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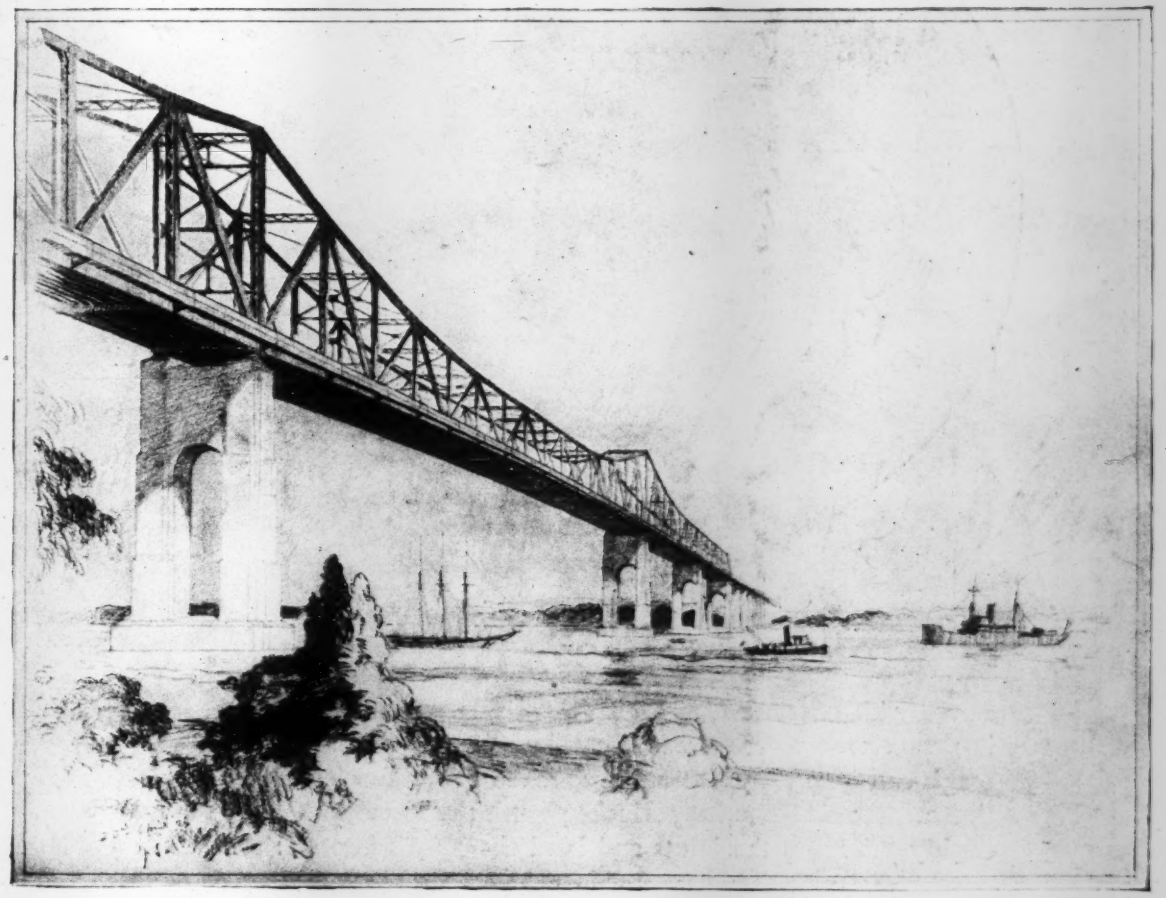
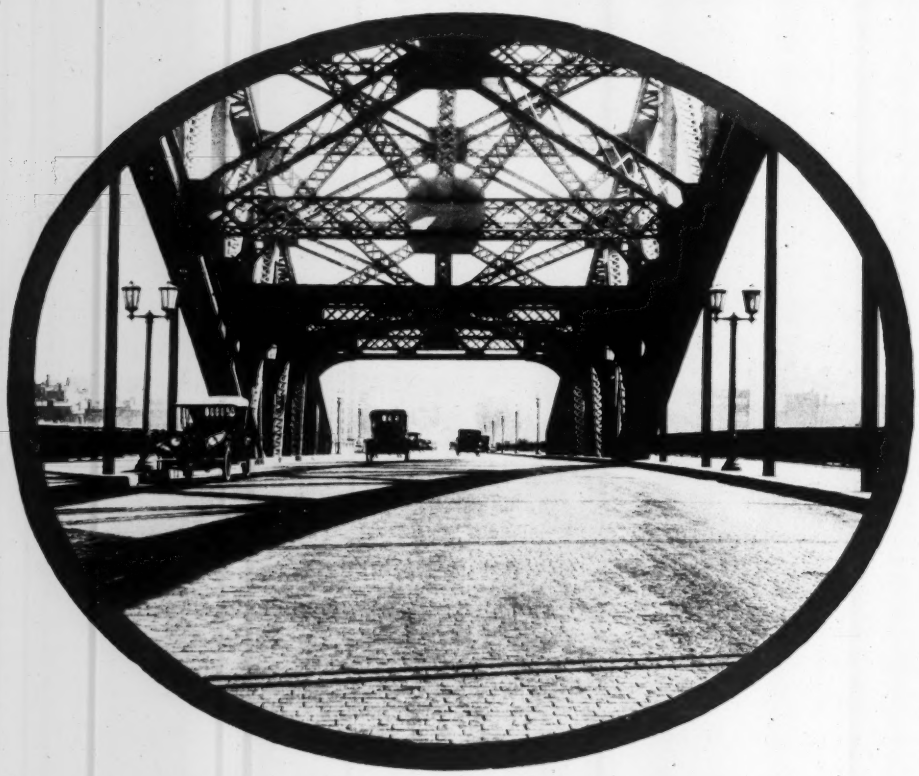


High-Level Cantilever Bridge Across Arthur Kill Now Under Construction Between Tottenville, Staten Island, and Perth Amboy, New Jersey

In This Issue

Percentage Renewals and Average Life of Railway Ties—Rail and River Terminal at Cincinnati—Vertical Butterfly Gates on Exchequer Dam—Curved Arch Spans in Scotia-Schenectady Concrete Highway Bridge—Plant and Methods for Building a Dam Under Below-Zero Conditions

KREOLITE



Bridge Spanning Cuyahoga River, Cleveland, Ohio

Paved with Kreolite Lug Blocks this bridge spans the river connecting two streets where traffic is continuous and heavy. Laid with the tough-end grain uppermost and made from thoroughly seasoned timbers, the Kreolite Lug Blocks permit the Kreolite Filler to thoroughly penetrate the joints and bind the blocks into one solid unit.

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FRANK C. WIGHT
Editor

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A Great Experiment

IT will be some months before the Holland vehicular tunnel under the North River at New York is opened to regular traffic but the beginning of the end of the construction period was marked last Saturday when the governors of New York and New Jersey went in motor cars to meet each other at the state boundary line under the middle of the river. The great experiment in a new traffic artery to the metropolis will soon be started. That experiment is not in the method of construction, for that was merely an extension of well known methods, nor even in the ventilation, which seems to worry the populace but which has only an infinitesimal chance of not being successful. But only the future can show how serious a problem in street congestion will be created in the already overcrowded streets of New York, and in no less proportion though less in degree, in the streets of Jersey City. Traffic improvements in our great centers have a way of overleaping themselves. They create new demands by the very satisfaction of old demands. This initial opening of Manhattan Island to the west will illustrate this to a superlative degree, and no one can tell until it has gotten fairly into operation just what sequels in new street openings, new river crossings and even transformation of business and housing centers it portends.

Construction Demand Continues

BUSINESS forecasters have been making much lately of the "falling off in building" during July and the beginning of August. They have been professing to find in this recession the only unfavorable indication in the outlook for future business. Building, they all assume, is a basic industry in that it is preliminary to all other production, and therefore when building falls off it is a fair presumption that the demand for increasing production is slackening. This is good enough logic, but it is a question whether the statistics on which the present concern is based have been sufficiently analyzed. It is true that during July and August there was a falling off in residential building, both from previous months of this year and from the same months last year. On the other hand there is not yet in sight any perceptible falling off in engineering construction or in building construction other than residential. It will be remembered that at the beginning of the year it was felt that the continued increase in construction could not persist and that there would have to be a break some time during the year. It was freely predicted by a number of authorities that that break would come about July. It is quite possible that these "hunches" of breaks in construction are back of the general impression that building is falling off. Increasing residential demand would merely indicate a continued failure to supply the higher living standards that prosperity has brought, but residential building may become saturated and prosperity still continue. General engineering construction, however, and building construction other than residential indicate a basic demand for manufacturing and producing necessities which augur well for future production of general commodities. So far, at least, that demand has not apparently slackened and until it does show some signs of slackening one need not be too much concerned about the immediate business future.

Secret Specifications

A GENTLEMAN with the credulous turn of mind peculiar to reformers writes in the September *Harper's* that "the federal government saves a hundred million dollars annually by purchasing materials, not on the stimulation of high pressure salesmanship, but according to specifications laid down by the Bureau of Standards" and that a proportionate saving might be made by every purchaser, private or public, were it not that the "business world" in some sinister fashion makes the government keep secret the great knowledge of materials that the Bureau has built up, and uses only for federal purchases. There is just enough of truth in this kind of pseudo-information to make it vicious. The Bureau does make tests and write specifications. They are excellent tests and adequate specifications. Doubtless they save the government money. But if they are secret someone in authority had better get a new press agent for the very active one the Bureau now employs. And if the tests are any different from those used preliminary to specification by hundreds of other testing laboratories, the three or four thousand members of the American Society for Testing Materials had better get some one to teach them their business. So long as the intelligentsia stick to academics they are at least entertaining; when they get near to facts they are apt to become absurd.

The Interfering Drawbridge

IN Chicago has arisen now the problem of the interfering drawbridge. Rules laid down when navigable waters had paramount rights because they were commercial necessities are cramping transportation there just as they are on the roads crossing the Jersey rivers west of New York City. Chicago River drawbridge interference with street traffic has assumed serious importance with the enormous growth in that traffic. Some immediate remedy is needed and the city authorities are working for a change in the periods during which the bridges must remain closed. The rules providing for the accommodation of river traffic are in the hands of the War Department, but the rules are old and have not been modified to meet the present conditions of limited river traffic and congested street traffic. A score of bridges in the heart of the city, carrying general street traffic and three of them carrying dense elevated railway traffic, must be opened whenever

necessary, except from 6:30 to 9 a.m. and from 4:30 to 6:30 p.m., but the vehicle and rapid transit traffic continues in almost even volume all through the day. Thus, an occasional tug, dredge or unimportant craft may delay thousands of people in going to and from business. With the decline of freight traffic on the river and the removal of local steamship facilities from river docks to the Municipal Pier in the lake, this condition is anomalous, and action has been started by the city authorities to establish the "closed" hours as 7:30 to 11 a.m. and 3:30 to 6:30 p.m. The War Department, even with its solicitude for river navigation, will find it difficult to justify a continuance of the old rule.

Thickened Edges

ACCEPTING federal aid road projects as a just index of changing practices it is interesting to note how the thickened-edge pavement section has increased in favor. From recent figures of the Bureau of Public Roads, counting projects only, it is found that 98 per cent of all pavements in 1921 were either of uniform thickness or thicker at the center and that in 1925 over 80 per cent of all had thickened edges. This computation is based on number of projects instead of pavement mileage which would give a truer comparison, but as the average project length is presumably about the same for all pavement sections the percentages are probably not greatly distorted. It is more significant, however, that the thickened-edge pavement is settling down to a standard 9-in. edge depth with a center thickness varying from 5 to 7 in. but most often 6 in. There are some 10-8-10 pavements and in 1925 there was one unusual section of 12-6-12. These thick pavements were evidently for special heavy-traffic roads; the normal 9-6-9 slab is the standard 18 and 20-ft. road pavement.

New Research in Construction

THE development of a rational method for determining the cost of excavation by hydraulic dredges is the interesting task undertaken by the engineers of the Puget Sound Bridge and Dredging Co. A paper read by Roy E. Miller, chief engineer, at last month's Seattle meeting of the American Society of Civil Engineers describes progress. Briefly the thought behind the undertaking is that since the character of the material to be handled determines the difficulty of excavating, of pumping and of retaining within the fill area the behavior of any material may be predicted from the accumulation of behavior data on other material. That is, by determining the properties of earths of which the working characteristics and cost factors are known and doing this over a considerable range of various kinds of earth, it is reasoned that thereafter when a new earth is in question, if its physical properties are determined and compared with the physical properties of earths whose costs of working are known, the comparison will furnish a basis for predicting the cost of working the new earth.

Thus far the investigation has progressed to the development of a tentative series of tests to determine earth properties which affect the difficulty of excavation. There are fourteen of these tests, the description of which takes a large part of Mr. Miller's paper and can only be referred to. The important fact for dredge operators to observe is that for three years this system of test analysis has been in use and has been of great help. As the records have grown in volume their practical usefulness has increased. It is not contemplated that test analysis can replace judgment and experience in estimating dredging costs but interpreted by judgment and experience it is a decided help in this difficult task.

This is the important fact for contractors to note. It is more important to note that here is an excellent example of research applied to a problem of practical contracting; it is definite testimony of the possibility of developing and improving the technique of construction by research methods. It is prophetic too, may we not feel, that this forward looking investigation in dredging technique is formally made known in a paper presented to the national society's new division of construction still without a determined purpose or even coherence of thinking to justify its creation. Is not research in the technique of construction its golden opportunity?

Who Benefits from Parking Privileges?

PARKING automobiles on business streets is becoming one of the most critical of our municipal problems, for it is one which equally applies to the town of 5,000 and the metropolis of 5,000,000. The historic privilege of drawing a vehicle up to the curb and leaving it there indefinitely is reluctantly given up, but slowly it is being impressed upon everyone that the street is a thoroughfare and not a garage, and that the rights of the many may be best served by giving more space to the moving vehicle than to the standing one. To go back to the old and sometimes quoted rule, "No one can make a stableyard of the King's Highway."

In Norfolk, Va., an exceptionally able commission has just made a general traffic survey of the city. What it has to say regarding parking is pertinent enough to warrant mention, because the deductions apply to all localities and because they are deductions that many engineers have tried to impress on the deaf ears of merchants. The commission says, for instance, that on the principal car-line thoroughfares one-half the street width is given up to parking space, that it makes no appreciable difference whether the curb lanes be used by only one parked car or cars parked solidly, for in either case such a lane cannot be used for passenger vehicles, and on busy streets there is practically no difference so far as flow of traffic is concerned between 10 min. and all-day parking; there may be a change of cars but not a change of conditions. The commission further notes what is almost a universal fact. Merchants object to short-time parking rules or to no-parking rules under the impression, which the commission believes to be false, that parking adds to their business. The commission finds, however, that if equal rights to the curb space of everyone in a building bordering that space be considered, the parking right per establishment is reduced to almost a negligible figure. This is merely saying again what has been very obvious, that the average merchant who is clamoring for parking is not hoping to get parking space in front of his own building for his customers, but hoping that these customers will be able to utilize parking space in front of his neighbors' buildings.

The commission admits that a certain amount of parking, limited as it may be, must be allowed, for after all if streets are to be used for communication

and transportation, stopping and unloading and loading are part of the transportation facility, but it calls attention to the legal provision that streets are designed for communication and transportation and that the use of a portion of such streets for the purpose of loading and unloading passengers or goods should not be permitted unreasonably to interfere with that primary purpose.

Most important of all is the commission's conclusion that when the traffic load on the principal business streets has reached the point of saturation, it will be necessary to prohibit the present degree of parking or else be prepared to see the districts served die of strangulation. This latter point is most pertinent, because the merchants who are so clamorous for parking privileges seem to disregard the ultimate probability of such continued parking. They are looking for immediate rather than for future business. The ultimate good to a community may very well lie in a dissemination of business and the continued privilege of parking may hasten that dissemination, so that in the end the merchants who insist on the parking right may be serving the public good to their own disadvantage, though their intention is exactly the opposite.

An Old Trick But A New Hand

HENRY FORD, the champion of the people against the nefarious bankers of Wall Street, has been planning to resort to an old trick of some of those same bankers in order to gain complete control of his Detroit, Toledo & Ironton Railroad. Ford interests now control and operate the Detroit, Toledo & Ironton, the Detroit & Ironton, and the Toledo-Detroit railroads. Since taking them over they have improved the properties greatly and have diverted so much of their own traffic to them that the railroads have become very prosperous and soon will be paying back to the Fords a handsome return on their investment. But there is a fly in the ointment. A few stockholders of the D. T. & I. R.R., holding about 1 per cent of the stock, have consistently refused to sell their stock to the Fords, preferring to remain in the company and share in the profits under Ford management. True to his philosophy Mr. Ford does not want company in this venture which is turning out so well, and so, not being able to buy them out he proposes a not unfamiliar way of getting rid of them. He would sell the D. T. & I. to its smaller associate, the Detroit & Ironton, a railroad entirely owned by the Ford interests. In doing this there will be issued new stock of the latter road which will, presumably, be sold to the Fords, and the money so obtained will be used to pay for the stock of the D. T. & I., the stockholders of the latter company being given no alternative but to accept cash and at a price fixed by the company's—and Mr. Ford's—own valuation engineers.

The possibilities for a gross injustice being done to the minority stockholders by such a procedure are obvious. Fortunately for the minority this plan must be approved by the Interstate Commerce Commission before it can be put into effect. As yet the commission has not rendered its decision but an examiner for the commission has advised against its approval. His chief reason for opposing the plan is that such a sale would constitute an actual consolidation of the two properties and that such consolidation is, at the present time, forbidden by the Transportation Act.

By basing his decision upon the anti-consolidation provisions of the Transportation Act, Examiner Molster has placed it upon grounds where it is reasonably sure of meeting with the approval of the commission. But it is unfortunate that he felt it necessary to resort to the use of the anti-consolidation provisions because most authorities on railroad problems are agreed that their should be no orders forbidding actual consolidations before the commission publishes a complete railroad-consolidation plan. It would have been better if he had based his findings upon the merits of the present case. The fact that there is evidence of injustice being done to the minority stockholders is sufficient reason for rejecting the plan. One of the commission's chief functions is to protect the minority in just such cases. If this cannot be done without masking the decision behind some provision of the Transportation Act which does not cover the specific injustice then the act should be amended.

Rainfall A Local Issue

YEARS ago a statesman—or was it a politician?—declared in Congress that the tariff is a local issue. Rainfall is equally mutable, both in point of time and place. Engineers know this, or else learn it to their sorrow. The wiser of them realize that our rainfall and all other meteorological records are for too short a period to establish maxima or minima, and that even a thousand years might not establish absolute extremes. The rainfall at the Battery station of the U. S. Weather Bureau, New York City, on Aug. 12, broke the record for hour and half-hour totals, as reported in our news section, but the nearest approach to the Aug. 12 figures was only 21 years earlier—a mere trifling portion of time since the first rain fell on Manhattan Island. This record breaker, however, was only a local affair, for only a few miles distant, in Brooklyn, rainfall was much less, although heavy. At stations 20 to 100 miles north, the Aug. 12 rainfall for the entire day was not high, while somewhat over a hundred miles from the Battery the following day, Aug. 13, was the one of heavy rainfall at Lake Ashokan, although not much beyond that point so little rain fell as to contribute hardly at all to the reservoir inflow. That reservoir, which supplies New York City with some 500 m.g.d., fell lower and lower every day but one, the first three weeks in August, a period when the average New Yorker would have sworn that the reservoir must be filling rapidly, so frequent had been the rains there and so heavy on some days.

The moral of all this is that weather impressions are fallacious and that our meteorological stations are too few and have been in existence too short a time to serve as more than a general guide as to what may happen at any other time or place in the way of rain, frost or wind. The passage of years will slowly mend this so far as the time element is concerned, but it cannot be hastened by man. What he can do is to establish more stations, closer together than now, to make up space deficiencies—and meanwhile use available data with discretion. A large percentage of the meteorological stations are few and far between and how to multiply them is a serious problem but in all thickly settled regions the stations might readily be multiplied many fold by municipal and other agencies working in co-operation with the Weather Bureau. As these are multiplied our rainfall records would become more and more dependable, and less local incidents.

Dam Construction in Winter on the Androscoggin

New 27,000-HP. Hydro-Electric Plant in Maine Containing 90,000 Cu.Yd. of Concrete Involved Special Plant Arrangement for Mixing and Conveying Hot Material

WELL ordered plans and equipment for cold weather work enabled over 40,000 cu.yd. of concrete to be placed last winter in the dam of the Gulf Island hydro-electric plant of the Central Maine Power Co. This operation on the Androscoggin River some 30 miles north of Portland is the largest of its kind now in progress in New England. As planned, two winters' work were called for and as Maine winters are long and cold a governing requirement was provision of cold weather methods and plant. This and high water phases were the chief controlling conditions of construction. There were engineering problems of design and location and some of them will be referred to but here is primarily an article describing the doing of work and not the design of structures.

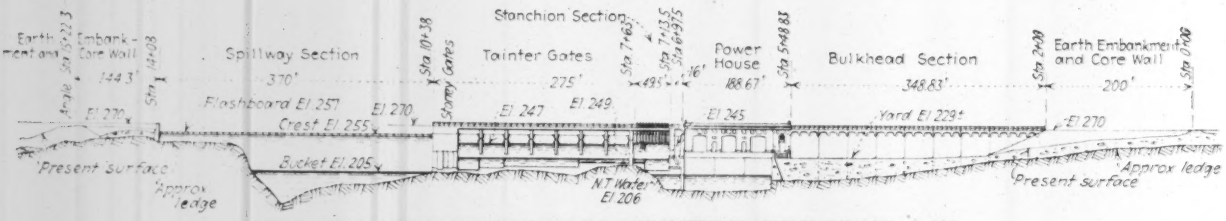


FIG. 1—DIAGRAM ELEVATION OF STRUCTURE, GULF ISLAND DAM

Location and Structures—Gulf Island splits the Androscoggin into two channels about 4½ miles above Lewiston. The pond of the Androscoggin Electric Co. at Lewiston reaches virtually to the lower end of the island. The new dam, to get the full head, had therefore to be located at Gulf Island or nearby upstream. Surveys and test pits disclosed about equivalent foundation conditions at the island and above it and about equal quantities in the dam structure. The island location, however, because of the split channel, afforded shorter cofferdams and more easy control of the river during construction and it was therefore adopted. The diagram plan and elevation, Fig. 1, and other drawings indicate the topography and the general structure.

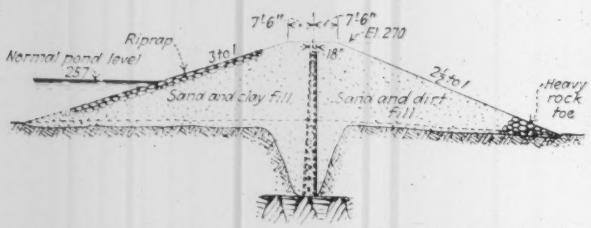


FIG. 2—SECTIONS OF DIKES FLANKING CONCRETE STRUCTURE

Including its flanking earth dikes the Gulf Island dam is 2,600 ft. long. Of this, 1,323 ft. are concrete structure, the maximum section of which is 110 ft. high. Fig. 1 indicates the several types of cross-section and these are shown in detail by Figs. 2 to 5. With the elevations shown on Fig. 1 the dam will form a pond about 10 miles long and 1 mile maximum width holding about 4,000,000,000 cu.ft. Between flashboard elevation and tail water elevation the difference (maximum head) is 51 ft. Of the several types of cross-section explanation is called for only in respect to the gate sections. The Tainter gate section was introduced solely as a measure of pond-level control. Raising of the pond level (El. 257) by flood introduces a hazard of land damages and the Tainter gate section, by giving additional floodway as desired, avoids this hazard. The Stoney gates provide for stream flow as construction closes the natural channels, and afterwards, as is legally necessary, maintain the normal flow when on any occasion it is not coming through the power house or over the spillway.

In planning structure the particular points of attention were: (1) the full provision against uplift, (2) the penstock and draft tube design, and (3) the concrete control. Provision against uplift is best understood by means of the plan and section, Fig. 7. The theory was: (1) to cut off under flow by grouting the ledge and (2) provide easy drainage for any water that might leak through the grouted zone. It was felt that one line of grout holes always left some uncertainty about the complete sealing of the ledge and so two lines 6 ft. apart were drilled. A test of tightness was then made by means of an intermediate line of test holes. A neat cement grout was put in under a pressure of 50 lb. until the rock would take no more. The

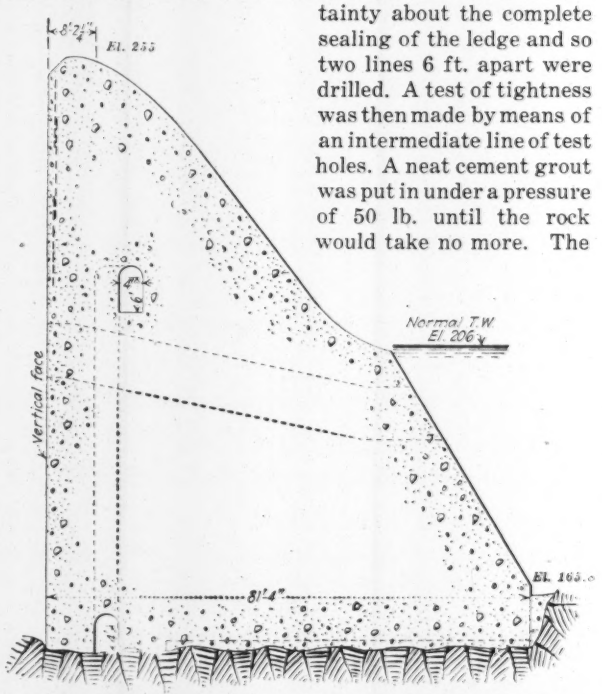


FIG. 3—SPILLWAY SECTION CROSSING WEST CHANNEL

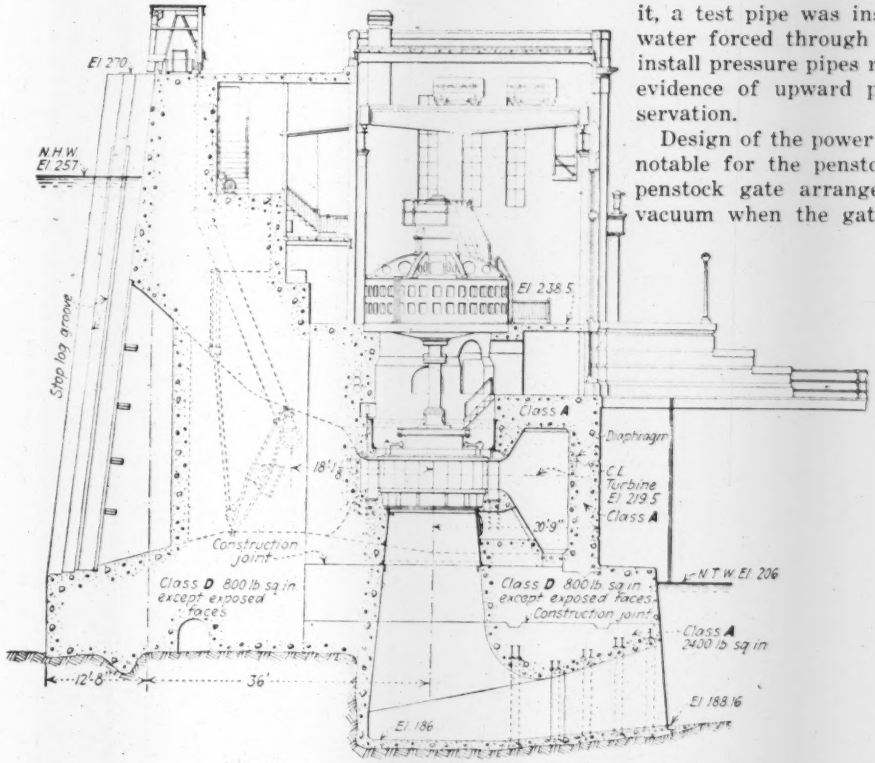


FIG. 4—POWER HOUSE SECTION INDICATING POWER AND OPERATING UNITS

it, a test pipe was installed near the drain head, and water forced through the drain. A final task was to install pressure pipes reaching to the dam top by which evidence of upward pressure can be kept under observation.

Design of the power house section (Fig. 4) is chiefly notable for the penstock and draft tube details. The penstock gate arrangement, the air pipe to prevent vacuum when the gate is closed and any consequent backing up into the wheel of the tail water, and the absence of draft tube cone and curved surfaces generally are the outstanding characteristics. As indicated by the section, two classes of concrete are used: Class A testing 2,400 lb. compression in 28 days, and (2) Class D, testing 800 lb. The higher test mixture is used in exposed surfaces and where special strength is required. It is virtually a 1:2:4 mixture with about 8 per cent, by volume of cement, of hydrated lime used with the idea of thus getting a tighter concrete and a more workable mixture. For concrete around the scroll cases and in some other parts Cal was used also as a means to greater

test water pressure was 80 lb. and it was expected to hold steady at this amount. Fig. 7 shows the arrangement and the spacing of the holes for the grout seal.

Drainage was provided first by a gallery running the full length of the dam following the ledge profile and by weep holes in the bottom of this gallery. Across the dam, as shown by Fig. 7, box drains were placed every 12 ft. with outlets at the downstream edge. Two weep holes were drilled in the bottom of each drain. These box drains were board hoods filled with loose stone. To make certain that the drain was "clear," that mortar from the concrete had not seeped in and closed

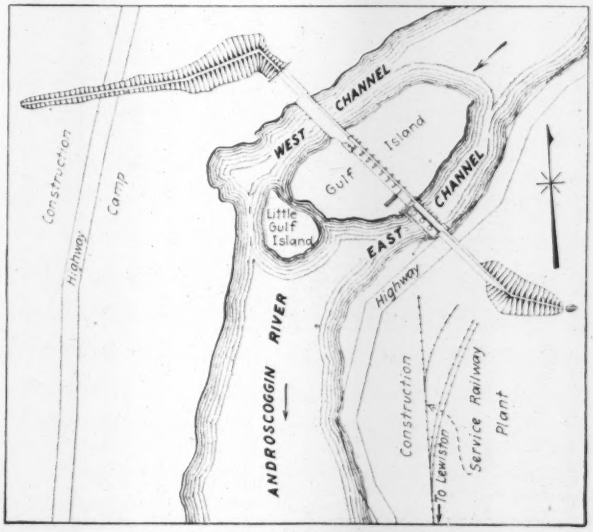


FIG. 5—LOCATION PLAN OF DAM, CONSTRUCTION PLANT AND CAMP

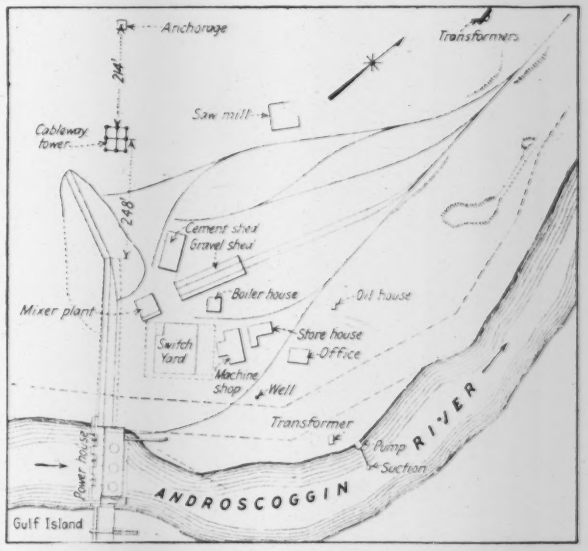


FIG. 6—DETAIL PLANT LAYOUT ON EAST SIDE

density. Class D is about a 1:4:8 mixture. Tests were constantly made of 6 and 8-in. cylinders to keep control of the concrete.

Of the power plant equipment only a general statement is made. There are three 9,000-hp. units of Allis-Chalmers wheels and General Electric generators. Arrangement of equipment is shown by Fig. 4. The total cost of the development will be about $5,000,000.

Developing Construction Plan—As stated, the location of the dam across Gulf Island was largely decided by the fact that it facilitated river control during construction. By closing one channel, fully two-thirds the

length of the dam could be built across the closed channel and the island, with a full channel always remaining for waterway. This was the first element of the construction plan. Construction was begun Oct. 2, 1925. The work on the dam called for 20,000 cu.yd. of rock excavation, 43,000 cu.yd. of earth excavation, 57,000 cu.yd. of fill and 90,000 cu.yd. of all classes of concrete.

With a 15 to 18 months' construction period, beginning on the verge of winter, work had to be carried

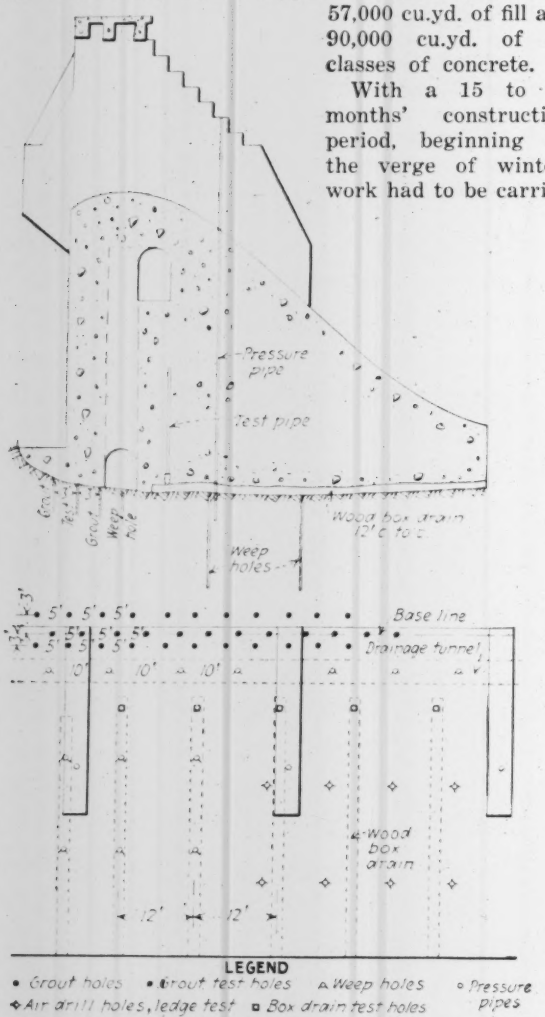


FIG. 7—PROVISIONS AGAINST UPLIFT, TAINTER GATE SECTION

through one winter and at least part of a second and it had to be carried over two seasons—spring and fall—of high water. The freshet periods were the critical points of the schedule. The first channel had to be entered and the dam brought above high water, before March 15, 1926. Actually this stage was reached March 7, 1926. Then the work had to be into and out of the second channel before the fall floods in September. Present progress indicates a certainty of this.

Because the west channel (Fig. 5) had greater capacity for handling the spring floods the east side was preferable for starting construction. Also a start from this side permitted earlier work on the power-house and preparation sooner for setting wheels and generators and the other particular work of machinery installation. Also the switch and transformer yard and the permanent storage yard of the power plant were to be on the east side and must be graded for and so

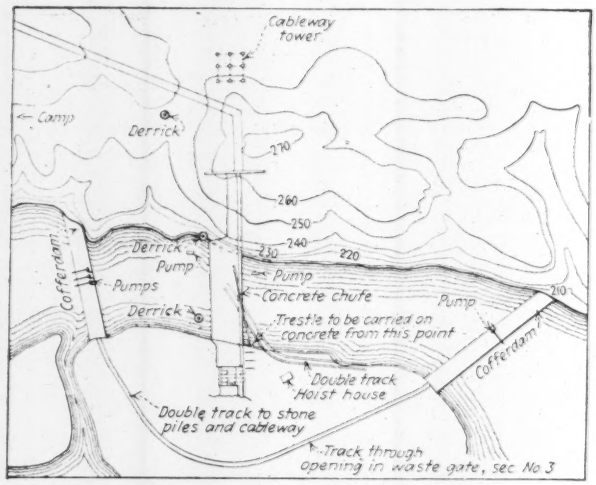


FIG. 8—DETAIL PLANT LAYOUT ON WEST SIDE

this side best fitted in for the construction plant location. On the basis of starting in on the east side and of the seasonal conditions the operation scheduled itself naturally into three construction periods roughly (1) from beginning work (Oct. 1, 1925) to the spring high water (say March 15, 1926), (2) from March to the autumn high water in September, and (3) from the fall freshet period to the end of construction.

From these time divisions came roughly three divisions of physical work: (1) Spur track from the job to the Maine Central R.R.; cofferdams in the east channel; erection of construction camp and plant; preparing foundations for the east part of the dam, and concreting to at least El. 220. (2) The remainder of all concreting except in the west channel; cofferdamming and excavating the west channel and bringing the concreting up out of high water; embankment construction; beginning equipment of power house. (3) The remainder of the concreting and earth work, finishing

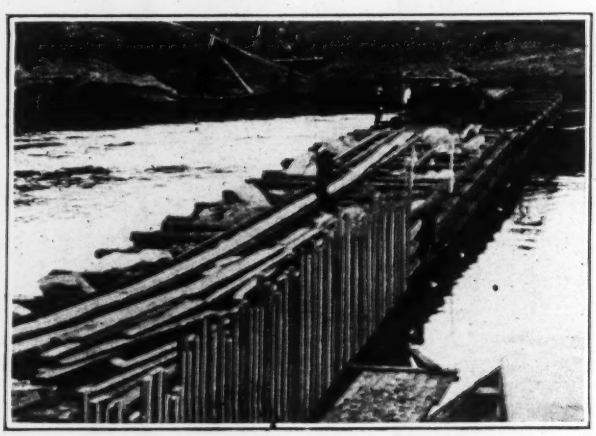


FIG. 9—WEST CHANNEL COFFERDAM CONSTRUCTION

the power equipment and closing up operations. In the main this division of the work has prevailed but there have naturally been both over run and under run in individual parts and general overlapping of operations.

Developing Access and Plant—Construction began Oct. 2, 1925. On the east side there was an old dirt road from Lewiston 2½ miles away. This was used to bring

in some supplies and lumber for preliminary work, but it was no adequate way for handling the large yardage of construction materials and equipment and power house machinery. Again the most likely source of aggregate was a gravel pit at Leeds Junction about 15 miles away on the Maine Central R.R. Direct rail delivery was decided on and a construction spur was built from near Lewiston to the construction plant, Fig. 5. This was a standard-gage line with old 67-lb. rail; with some 16,000 cu.yd. of grading and one 40x250-ft. trestle a line 2½ miles long with 4-per cent grades and 12-deg. curves was secured. It took about six weeks to build. To the west side where the camp was lo-

FIG. 11—CONSTRUCTION PLANT COMPLETELY COVERED FOR WINTER WORK

FIG. 10—TYPICAL FOUNDATION EXCAVATION IN BASTARD GRANITE

cated access is by highway. Also about a mile away there is an interurban electric line. Separation of plant and camp was made to keep camp activities and visitors away from the most active construction operations.

The plant layout is indicated by Figs. 6 and 8. Both plant and camp were begun with the railway and as far as possible timber cut from the flowage area and sawed by contract was used. Except for the concrete producing units, construction of buildings and their equipment were about as is usual in well managed operations. There were a planer and cut-off, rip and band saws in the saw mill and a floor for laying out forms. In the machine shop were lathe, drill press, shaper, power hack saw and pipe threading machine. The camp units were a mess hall and bunkhouses, steam heated, and with wash rooms, laundry room, showers and all the modern equipment of the best construction camp practice.

Direct rail delivery was emphasized. The yard track system was developed to lay down all material as closely as possible to the points of fabrication or ultimate use. All deliveries were made by the Maine Central R.R. to the spur and there two construction locomotives took cars to destination. Besides, there were three standard flat cars for job service, and three hand push cars. Miscellaneous deliveries were by truck and tractor. Other carrying equipment and all other plant comes in for attention more properly in connection with two main operations of (1) preparing dam emplacement and (2) concreting dam and power house structures.

Preparing Dam Emplacement—Preparing the foundations for the dam structure was a rather simple task of earth and rock excavation except in the river channels. Here there was some deep excavation after laying the bottom dry by cofferdams. Stone-filled, timber-crib dams sheeted outside were built. The water depth was

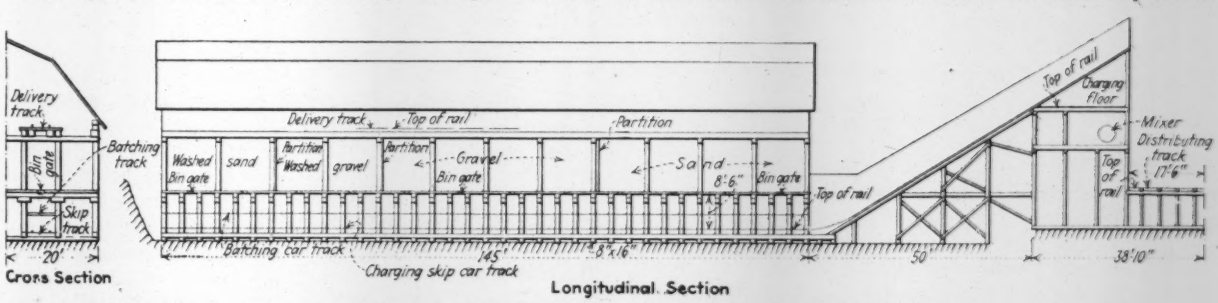


FIG. 12—DIAGRAM OF HOUSED AGGREGATE BINS AND MIXING PLANT

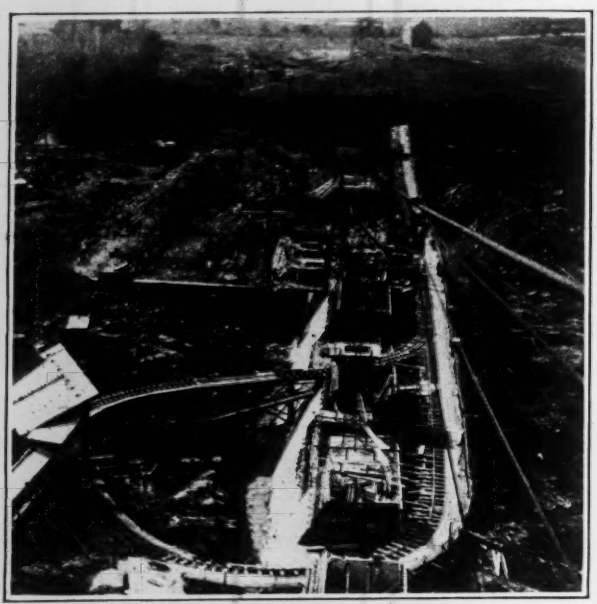


FIG. 13—CONCRETE DISTRIBUTION TRACK AND CABLEWAY

16 to 18 ft. running up to 23 ft., and the work had to be done in a 3 to 5 ft. current. There were no complications. A considerable earth and rock excavation plant was installed; one ¾-cu.yd. and 1¼-cu.yd. power shovels, three compressors, ten drills, nine dump cars, 18 dump wagons, a 10-ton crawler crane, ten scale pans, clamshell and drag buckets, road grader, tractor and small tools. This outfit was largely employed in embankment building as well as in preparing dam emplacement. Fig. 9 gives a good idea of the cofferdam work and Fig. 10 shows characteristic rock excavation.

The rock was a bastard granite, fairly easily drilled and breaking nicely. Much of the rock excavation had to be done in winter and except that the air was heated by a coke fire and a coil in the pipe no special methods were employed. There were three compressors having an aggregate capacity of 900 cu.ft. and giving about 80 lb. pressure at the drills. Generally 60 per cent dynamite was used. Most of the rock was handled out by derricks and used as riprap, plums and cofferdam fill. All concrete structure including the core walls in the shore dikes was carried down to solid rock.

Concreting Methods for Winter—The particular task of the dam construction was the concreting. It was made so by the conditions of (1) winter work and (2) an output schedule to meet flood periods. It was the end of December, 1925, when all conditions of plant and foundation preparation were ready for concreting. The first concrete was put in Jan. 1, 1926, and from then on the output has been 360 cu.yd. each weekday.

The production unit is shown in general view by Fig. 11, in which the complete enclosure of every part is the first feature observable. Sand and gravel cars from the pits 15 miles away come into the bin house and then dump into the 800-cu.yd. gravel space or the 400-cu.yd. sand space. There is room for six cars on the bin-house tracks and the bins hold 300 car loads. Besides the bin capacity there are stock piles just east of the bin approach tracks in which generally about 10,000 tons of aggregate are stored. When wanted this stock is loaded by a crawler crane and clamshell into cars which are run into the bin house. Fig. 12 indicates, in diagram, the bin house structure—it is completely inclosed even to doors at the entrance end. It will be noted that there are twin receiving tracks over the bins. Under them are twin batching car tracks and twin skip car tracks, one of each directly above each other on each side. Two batching cars on each track ply back and forth pulled by an endless cable; they are partitioned and proportion the aggregate received from the bin chutes. They dump into skip cars, one on each track, which are pulled by cable up the incline to the charging floor. Cement in bags comes to the same level by belt conveyor from cars or house (Fig. 11). There are two 1-cu.yd. tilting mixers which discharge into hopper cars on the distributing track.

This arrangement of plant used before by the same contractors has demonstrated exceptional reliability and capacity. Here the notable features are the housing and heating. A central heating plant has an 80-hp. and a 60-hp. boiler; and from it steam is piped to all plant buildings and to the dam where concrete is being

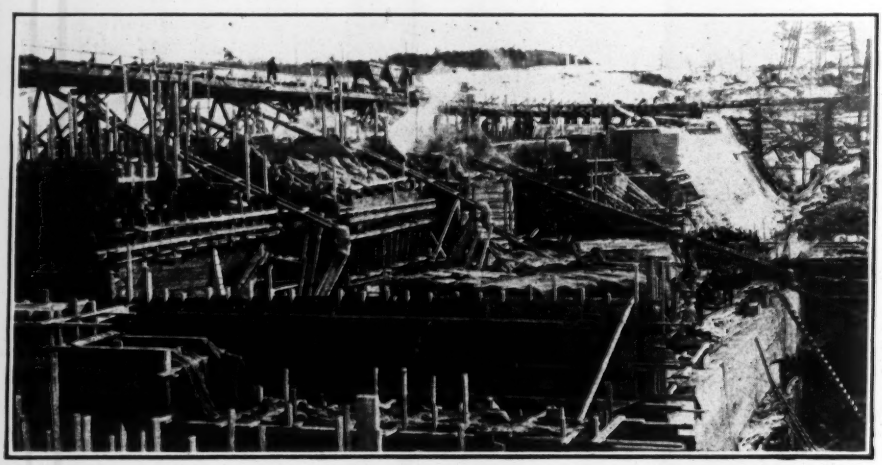


FIG. 14—PLACING AND PROTECTING CONCRETE IN WINTER

kept warm. In the bin house there are 2-in. pipes on the bin bottoms and also three rows five pipes high on the posts inside the bins. With doors closed the bin house was kept at 60 deg., which thawed the gravel cars over night and kept the material well warmed. A 9,000-gal. tank with a steam coil in the bottom heated the mixing water to 100 deg. Mixer house, cement house and all conveyor and other working enclosures were heated. In all the work of producing concrete there was not an unsheltered operation or one without comfortable warmth. Under the conditions there was no output inefficiency due to cold and the concrete left the mixer at 80 to 90 deg. temperature.

A cableway and a service railway were installed for distribution although the cableway was only an in-

cidental means for placing concrete. Perhaps 10 per cent of the concrete will be handled by cableway. It being employed chiefly for general service, lifting and carrying. It has a 1,600-ft. span, 135- and 140-ft. towers, 2½-in. cable and carries 15 tons. It is operated by a 300-hp. electric hoist. Both cableway and service track are shown by Fig. 13. The track loops in front of the mixers which discharge into 2½-cu.yd. hopper cars hauled in trains of two and three by 3-ton gasoline locomotives. The track gage is 36 in. From the cars the concrete is chuted into the forms as shown by

Generally the dam is concreted in sections 39 ft. long and 8 ft. high. Referring to the winter operations, when concreting was started from the rock foundation the area was covered with canvas blocked up from the rock and the inclosure kept warm over night by live steam and salamanders. This thawed and warmed the rocks so that no ice film or chilling interfered with the bonding and setting of the first layer of concrete. The concrete left the mixer at 80 to 90 deg., and in the 2½-cu.yd. containers it was found that it did not cool appreciably in half an hour. The heat of chemical action apparently made up for any loss in this time by radiation. Over night and as much as possible at other times the placed concrete was sheltered with canvas kept warm inside by steam jets. There were employed, it will be observed, no uncommon winter placing methods but the common ones were applied thoroughly. This added 12 to 15 per cent to the normal warm weather cost. In the first winter's work there was not found a fault in the concrete due to freezing.

Direction of Work—As stated, the Central Maine Power Co., Augusta, Me., is developing the Gulf Island power. Frank H. Mason is chief engineer and H. L. Baker is resident engineer. Morton C. Tuttle Co., Boston, Mass., is the construction manager with W. H. Ryerson and B. R. Value in charge on the work.

Filled Land Forms Extension of City of Bombay, India

Concrete Sea Wall—Water Front Reclaimed by Hydraulic Dredges—City Planning Development on New Site

LAND reclamation and city planning on a large scale are being carried out at Bombay, India, where an area of about 1,200 acres is being filled along the water-front. The southern end of the city is a narrow peninsula having the harbor on the east, where the main filling is, and Back Bay on the west. A broad drive will extend along the water front and another along the center of the new site, with an underground railway under the latter and connecting with the two great railway terminals at the northern end. Parks, public buildings, offices and residential districts will be laid out. This improvement and extension of the southern end of the city was noted in connection with the new railway and terminal facilities in *Engineering News-Record* of Sept. 21, 1922, p. 485.

As the first step in the construction work, a sea wall four miles long is being built, consisting of a massive concrete structure on a rock rubble mound having a top width of 20 ft. at the water line, with slopes of 1 to 1½. The outer slope is protected by a layer of quarry blocks of 4 to 7 tons in weight. Upon this mound the monolithic concrete wall is built, with dovetailed blocks or sections 20 ft. long, 16 ft. wide and 8 ft. high, having a 3½-ft. parapet wall on the water side. At some parts these blocks are hollow, the interior space being filled with loose rock and covered with a concrete slab.

For the northern end of the sea wall, where there is a considerable depth of soft material, a temporary pile trestle carries two railroad tracks for a pair of pile-drivers and the rock trains. The quarry is about twenty miles distant, on one of the main line railways. The work is handled in trains of 20-yd. side-dump cars, which are dumped on both sides of the trestle and between the two tracks. For the southern end, where the bedrock is nearly exposed, a narrow mound is first built by 5-yd. end-dump cars, and is then widened by side dumping from trains of the 20-yd. cars. When the mound has reached full height, it is leveled off and forms are placed for the concrete wall blocks. Finally, tracks are laid along the wall and a crane places the big quarry blocks on the water face of the mound.

Concrete and brick storm-water drains are carried through the rock mound. Those in the southern portion are built on a rock-filled trench under the mound; but those in the northern portion have a pile foundation enclosed by steel sheetpiling which extends to the toes of the stone fill, while a concrete apron beyond the outfall prevents erosion or disturbance of the soft material.

Two hydraulic dredges are used in making the fill behind the sea wall. The largest of these has a capacity for dredging 2,000 cu.yd. per hour in 70 ft. of water and delivering it through a 42-in. pipe line to a distance of 5,000 ft. A triple-expansion engine drives the pump, two compound engines drive the twin screws, and a smaller compound engine drives the cutter head on the suction pipe. This machine works in the harbor and as it is about 6,000 ft. from the site of filling, it delivers the material to a floating pumping station which re-handles the material and delivers it to the site. A smaller suction dredge on the Back Bay side discharges the material directly into place, but when it works farther out an intermediate pumping plant will be installed.

The discharge line of the big dredge is in 48-ft. lengths, each carried by a pontoon consisting of two 58-in. cylindrical floats 45 ft. long. On each pontoon is a hand hoist for the anchor chain, a walk or gangway, and a hand pump to handle water ballast in the floats and thus adjust the grade of the pipe line.

All this filling and reclamation work is being done by day labor under the direction of the Bombay Development Commission, of which H. A. Elger is chief engineer. The laying out of this new extension of the city is in charge of W. R. Davidge. Meek & Buchanan, of London, England, are consulting engineers for the entire project

Smokeless Garden Village Near London

Selsdon Garden Village, 11 miles from London, England, was officially opened July 24. The site was surveyed early in 1925 and construction started late that year, all as a private enterprise at a cost reported in *London Municipal Engineering* (London) as $5,000,000. There will be 250 semi-detached dwellings each equipped by the syndicate "with a gas cooker, a gas copper [boiler] and a gas fire" [for heating]. The village is located in "picturesque upland country."

Endurance Testing of Metals — New Developments

Axial and Flexural Endurance Equal—Grooves and Threads—Water Corrosion Found to Lower Endurance

STUDIES of endurance of metal under alternating stress were reported from three different laboratories at the annual meeting of the American Society for Testing Materials in June. All presented important new facts, as already noted in our report of the meeting (July 1, p. 20). A summary of the principal results is given in the following.

Direct-Stress Endurance—Extensive tests made in the research laboratories of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., and reported a year ago by Paul L. Irwin (*Engineering News-Record*, Aug. 20, 1925, p. 311), showed that for certain metals the endurance under alternations of axial stress, applied by an ingenious electro-magnetic stressing device, was substantially equal to the endurance limit found in reversed-bending fatigue tests of the more common type—the stress in the reversed-bending test pieces being calculated by the ordinary theory of flexure. In other words, the extreme-fiber stress in the flexural test piece and the average load on the axially stressed test piece were equal at the respective endurance limits of the test pieces. The metals experimented upon at that time—steel, bronze and cast iron—had a high proportional limit, well above the endurance limit, so that the stress distribution in the endurance tests probably followed Hooke's law. As an extension of this study, during the past year a series of endurance tests was made on metals whose proportional limit is considerably lower than the endurance limit. The net result of the new series of tests is to show that the *same conclusion holds* also for these metals, in spite of the apparent inapplicability of the common theory of flexure.

The metals experimented with were annealed electrolytic copper, annealed monel metal, and annealed nickel, the first mentioned of which has a proportional limit in tension as low as 1,875 lb. per sq.in. although its endurance limit was found to be somewhere between 10,000 and 11,000 lb. per sq.in. The results are combined in the accompanying table with those obtained last year.

Mr. Irwin concludes that the two groups of tests show the endurance limit under direct stress to be the same as that under bending stress regardless of the ratio of endurance to proportional limit.

Fatigue Effect of Grooves and Threads—Service failures of airplane propeller hubs led to a study of the effect of notches, grooves, threads and the like upon fatigue endurance, at the laboratory of the Army Air Service, McCook Field, Dayton, Ohio. Tests were made both on steel and on aluminum alloy, the steel being of both carbon and alloy type. Circumferential grooves of various widths, depths and shapes were turned in the specimens, the groove in each case being at mid-length (of a simple-beam specimen) so as to constitute the failure section. Other specimens had threads turned on the entire middle portion of the specimen. Simple tension tests were made on corresponding specimens, in each instance. The results, reported by R. R. Moore, are not wholly complete and conclusive because the number of specimens available did not in all cases suffice to give a complete stress-cycle curve of endurance, but the conclusions reached are well supported and not likely to be changed by further experiments.

In simple tension, the notched specimens usually developed higher tensile strength than unnotched specimens of the same area as the root section of the groove or notch, but in the repeated-stress machine the notched specimens were the weaker, their endurance limit sometimes being less than 40 per cent of the normal value. Even with a groove of ¼-in. radius, the endurance limit was only 80 per cent of the normal value. For a chrome-vanadium steel as well as for aluminum alloy, a 60-deg. V-notch and a 45-deg. notch with one straight side had about the same effect on endurance (for steel, endurance limits 21,000 and 24,000 respectively, as against 55,000 for the normal test piece; for aluminum alloy, 7,750 and 8,000 respectively, against 14,000 normal). These notches had root radii of .01 to .015 in. In general, the endurance strength of the specimen increased with increasing radius of root of groove. The decrease in endurance strength was not quite as marked in the aluminum alloy as in the chrome-vanadium steel.

	Static Test Values				Endurance Limits		
	Prop. Lim.	Yield Point	Ult. Stress	Elong., Per Cent	Bending Simple Beam	Bending, Cantilever	Axial Stress
0.15 per cent C steel, annealed	30,100	32,000	49,400	41	25,500		24,500
0.37 per cent C steel annealed	39,000	42,000	80,500	28.1	30,000		33,000
Chrome-nickel steel (0.68 Cr, 2.93 Ni)	100,000	113,000	133,700	18.4	55,000		56,200
Chrome-nickel steel (0.84 Cr, 3.33 Ni)	92,000	97,000	119,000	24.5	61,500		58,200
Manganese bronze, forged	32,500	79,500	105,500	8	16,000		17,500
Copper, annealed	1,875		31,200	60	11,300	10,100	*11,000
Nickel, annealed	16,000	30,000	82,750	50.9		38,000	41,500
Monel, annealed	14,000	38,300	90,600	46.8		40,000	*40,000

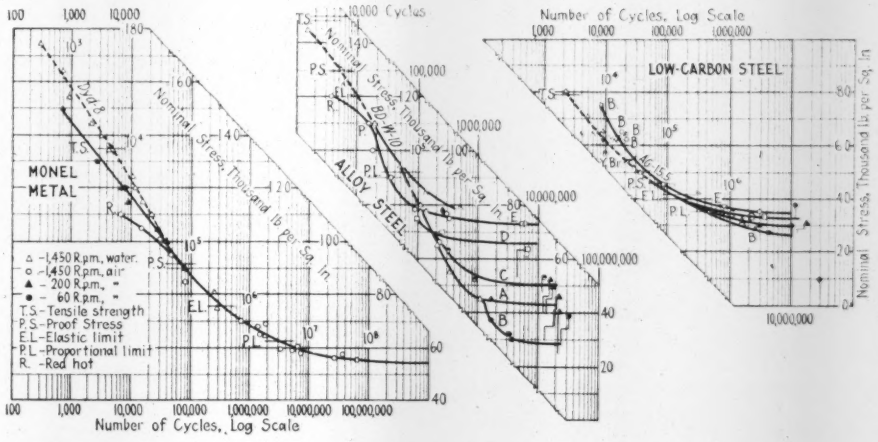
* Approximate.

A marked difference was found between test pieces with a single groove and continuously threaded test pieces. A No. 28 thread on a ¼-in. specimen brought the endurance limit down from 51,000 to 43,000 lb. per sq.in., while a single circumferential groove of the same form brought it down to 12,000 lb. A No. 24 thread or groove on a ⅜-in. piece made the two endurance limits 37,000 and 21,000 respectively.

Endurance of High Stress—Part of the continued endurance testing at the Naval Engineering Experiment Station, Annapolis, during the past year, was directed toward extending the stress-cycle graph to higher stresses and lower cycles than have been used previously. Endurance testing has generally been directed toward locating the endurance limit, for which purpose the applied stresses are kept close to the expected limit.

As the attached diagrams (alloy steel, monel metal and low-carbon steel) indicate, fatigue tests were carried out at bending stresses about three times as high (in nominal value) as the endurance limit, producing rupture in the extreme cases at as few as 300 to 400 cycles. In the first and second diagrams the upper curves represent these results. It was necessary to keep the specimen cool with a water stream in order to prevent serious lowering of the endurance strength by the heating of the specimen during the progress of

the fatigue test; one of the lower branches of the curve in each diagram gives the results for an uncooled specimen, and the intermediate branch in the monel metal diagram represents the reduced weakening effect when the testing machine was run at slower speed, the specimen still being uncooled. Dr. McAdam says that by use of water cooling "it was possible to extend the stress-cycle graphs upward to nominal stresses greater than the tensile strength and in some cases greater than the actual tensile stress at maximum load. At the upper limit of such graphs the specimens usually broke at less than 1,000 cycles." Test results on a 0.36 per cent carbon steel are shown in the third curve. Here the uncooled test specimens give higher results than the water-cooled specimens; they reached temperatures at



FATIGUE TESTS AT HIGH STRESS, AND COMBINED CORROSION AND FATIGUE

which the mild steel was stronger than at room temperature. In all cases the consistence and regularity of the observation points are noteworthy.

Corrosion and Fatigue—In the lower part of the stress-cycle curves, the results obtained with water-cooled specimens appeared abnormal, and were studied more minutely. As a result, it was found that this abnormality was caused by the chemical effects of water on steel. Recently in a brief discussion of corrosion and fatigue, Prof. H. F. Moore said (*Engineering News-Record*, Sept. 3, 1925, p. 377), "The accelerating effect of corrosion on fatigue is not known, except for high stresses, beyond the yield-point." The present results supply knowledge on this point.

The effects are brought out clearly in the alloy-steel curve in the adjoining diagram. It will be seen that the stress-cycle curve gives a lower endurance limit as the length of time during which the corrosive action of the water stream continues is increased. The most decided effect on the stress-cycle curve was produced during the first 4 hr. of the test. In this length of time the specimens, which were entirely surrounded by the water stream, remained fairly bright; small dull spots were visible, however, which on examination through a microscope proved to be oxide patches surrounding non-metallic inclusions or pits, and in most cases showing also a transverse crack passing through the spot. No similar spots or transverse cracks were found on specimens tested to failure in air. It was concluded that the low position of the endurance curve of the water-cooled specimens is due to failure developing by extension of one of the short, transverse cracks produced by the combined action of corrosion and stress.

Confirmatory evidence was obtained in tests in which the water stream was continued for different lengths of time; the lowest endurance values were found for those specimens which were exposed to the water for the longest period of time. Apparently also the damaging effect of corrosion increased with increase in the hardness of the steel. When the water stream was continued for 1½ million cycles (about 18 hr.) the endurance was lowered the maximum amount, and under this condition all the steels tested showed almost the same corrosion-fatigue limit (about 28,000 lb. per sq.in.), and the advantage of heat treatment in conferring endurance strength was practically eliminated.

Exposure to a water stream for 1½ million revolutions of the test specimen *without load*, followed by testing under load but without the water stream—in other words, corrosion followed by fatigue testing—showed very much less effect upon the normal endurance limit than corrosion simultaneous with fatigue. Dr. McAdam says that "the effect of rather severe corrosion prior to fatigue is much less than the effect of very slight corrosion simultaneous with fatigue. Even this relatively small effect of severe prior corrosion is probably due largely to slight corrosion under the rust patches continuing simultaneously with the fatigue."

The lowering of endurance limit by corrosion ranged for different steels from 3 per cent to 30 per cent for slight corrosion (water stream continued during 100,000 cycles) and from 20 to 60 per cent for severe corrosion (water stream for 1½ million cycles).

Two New Welded Steel Buildings

A steel industrial building, completely welded, was recently erected by the Pearl City Boiler & Manufacturing Co., of Jamestown, N. Y., at its plant. The structure is 40 ft. wide by 60 ft. long, 50 ft. high to the roof trusses, and is covered with corrugated steel welded to the frame. The columns carry a 5-ton crane runway extending the full length of the shop. All members of the framework were welded electrically, using Lincoln welders. Even the electrical fixtures and machinery shafting brackets were welded to the frame. Previously the same company had erected a 25-ton elevator shaft five stories high, of all-welded construction. George J. Graves, president of the company, reports that it is now building a steel garage of welded construction. In Decatur, Ill., an all-welded building has been constructed by the Mississippi Valley Structural Steel Co. In this building the first-floor beams are supported by basement columns, and the roof is carried by wall-bearing trusses. The connections between columns and beams as well as all truss connections are welded. The H-columns have cap, bases and self angles welded to them. Truss web members are riveted to the chords.

Rail and River Terminal at Cincinnati, Ohio

No Dock Structure—Barges and Freight Yard Served by Two Revolving Cranes on Levee and in Yard

A PAIR of 10-ton electric full-circle revolving traveling cranes located on the levee slope and top of bank constitute the main features of a simple and inexpensive water-front terminal now being built at Cincinnati, Ohio, for the transfer of freight between river vessels and railway cars or motor trucks.

Like most cities on our navigable rivers, Cincinnati has a long stretch of paved slope or levee, along which are moored wharf boats against which the steamers and barges lie, all freight having to be hauled up the slope by teams. In providing for a more convenient and

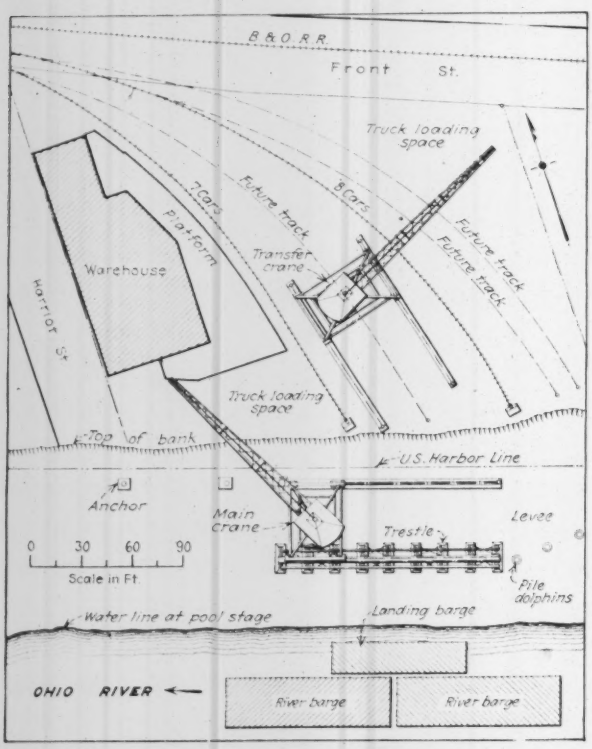


FIG. 1—CINCINNATI RIVER FRONT FREIGHT TERMINAL

economical system of freight handling, it was decided not to build a water-front dock with cranes or freight inclines, as has been done at some river ports, but to rely entirely upon cranes of long reach, requiring only simple foundations. These cranes, with their foundations and runways, a freight yard, a warehouse 140 x 60 ft., and a moored landing barge constitute the terminal, the layout of which is shown in Figs. 1 and 2. The site of the freight yard is above the water line of all except extreme floods. In addition to package freight, the terminal is adapted for handling steel, pig iron, cement and other bulk commodities.

Two concrete slabs or girders built on the slope of the levee, supported on 16-in. concrete piles driven to rock and with the lower one surmounted by a steel trestle, form the 150-ft. runway for the main gantry crane, which has a hoisting capacity of 10 tons at 100-ft.

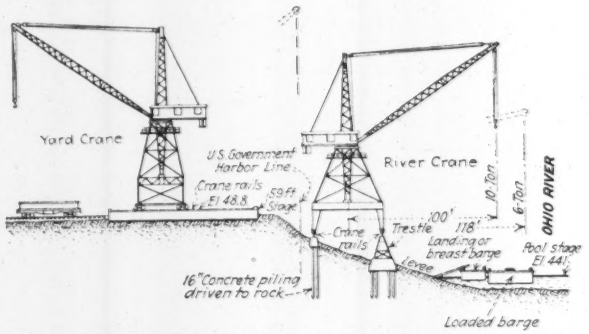


FIG. 2—REVOLVING GANTRY CRANES HANDLE FREIGHT

radius and 6 tons at 118 ft. Its boom reaches far enough to extend over barges at the pool or low-water level maintained by the dam below the city, and it can swing round to serve cars or motor trucks on the top of the bank. As the space thus reached on the bank is limited, the second crane provides for transfer to the main area of the yard. The latter crane, similar to the first, has a travel of about 100 ft. on rails laid on two heavy concrete girders or stringers. Two railway tracks will be laid at present, branching from the line of the Baltimore & Ohio R.R. on Front St., but there is provision for three additional tracks. It is estimated that the main crane can handle about 500 tons in a 10-hour day. These cranes were purchased from the U. S. Engineer Department, having been used in the construction of the Wilson Dam at Florence, Ala. Each crane has a 100-hp. motor for hoisting, 75-hp. for traveling and 25-hp. for swinging.

It is stated that more than 15,000,000 tons of freight were transported on the Ohio River in 1925, an increase of about 50 per cent over 1924, while the traffic for the first six months of 1926 shows an increase of some 2,000,000 tons over the corresponding period of 1925. The extensive project of Ohio River regulation by locks and dams is expected to be completed in 1929, when a considerable increase of traffic is hoped for. In view of the possibilities of river transportation of freight, modern freight-handling facilities were advocated in 1922 by the Cincinnati Chamber of Commerce, which in 1923 promoted the organization of the Cincinnati River-Rail Transfer Co. for this purpose, the stock being subscribed mainly by local concerns and citizens. Julian A. Pollak is president of this company, and its secretary is George W. Breiel, manager of the industrial department of the Chamber of Commerce. The terminal was designed by Bert I. Baldwin, consulting engineer, Cincinnati, Ohio. J. & F. Harig have the general contract, while sub-contracts have been let to the General Iron Works Co. for fabrication of structural steel and to Nolte Construction Co. for concrete and wood piling.

Sulphur Treated Cement Drain Tile

That the strength of portland cement drain tile may be increased very materially while its quality of absorbing water is decreased, by placing the tile in a bath of molten sulphur until completely impregnated, was demonstrated in a recent investigation at the Bureau of Standards. In some cases, however, such treating will not prevent deterioration of the tile. For instance a number of these tile placed in alkali soil in Colorado decomposed almost completely in two years, although tile unimpregnated with sulphur also decomposed.

Water Delivery Makes Long Haul of Batches Economical

With Six-Batch Truck Haul Averaging Seven Miles from Water-Front Proportioning Plant Contractor Paves 900 Ft. a Day

IN THE interest of economy and convenience of handling aggregate and cement the contractor for 12 miles of concrete road from Mattituck to Greenport, Long Island, has located his proportioning plant at a pier head 1½ miles off the line of his paving work. The dry materials are truck-hauled to the paver which has averaged 900 ft. a day of 10-ft. (half-width) pavement. The road is 20 ft. wide, and has an 8-7-8-in. section; a 1:1½:3 mix is used. Expansion joints are placed every 40 ft. All materials are brought to the plant by boat. The stone is trap rock from New Haven, Conn.; the sand comes from Port Jefferson, N. Y.; and the cement from a New York City warehouse. Materials are available within trucking distance but the economy of water rates made the described location of plant and method of material supply more economical.

PROPORTIONING PLANT LOCATED AT PIER
Photograph taken from platform of cement shed; barge being unloaded in left background.

Proportioning Plant—Two gasoline cranes operating ¾-cu.yd. clamshells handle the sand and stone. One of the cranes works continuously unloading barges while the other charges the 120-ton batcher bins with sand and stone. Both cranes are of the crawler type. Volumetric batching hoppers are used.

There is a total storage capacity for 3,000 cu.yd. of stone, 1,000 cu.yd. of sand and 2,200 bbl. of cement. The accompanying illustration shows the plant and material piles and their location relative to the barge mooring shown in the background. An attempt is made to keep this storage continuously as near the maximum as possible since storms on Long Island Sound often keep boats out of the inlet. The barges carry slightly over 600 yd. and draw 10 ft. of water. About three barges of stone and 1½ barges of sand are unloaded per week. The cement is taken from the boats in slings holding 8 or 10 bags. The location of the cement shed is indicated by the fact that the accompanying picture was taken from the cement-shed platform. The cement is deposited on a platform around the cement shed and batched directly into trucks in so far as possible. When the platforms are full, the bags are hand-trucked into the shed and stacked. Eighteen men comprise the labor force at the plant, a foreman, 3 crane operators and 14 laborers.

Paving Practice—Trucks equipped with compartment bodies for six batches of five bags each haul the dry material to the paver. The sand and stone are loaded first and the cement is placed on top. A tarpaulin is used to hold the cement. Such an order of loading saves one truck movement from the bins to the cement shed which would occur if the cement were placed between the sand and stone. The contractor finds that a satisfactory mix of the materials occurs in dumping into the mixer pan and that the tarpaulins hold all of the cement on the truck during transit. Placing cement in the trucks first is not considered as it does not slide out clean even when the truck body is at its maximum tilt.

Six batches are hauled except where the trucks must run on comparatively new pavement where the load is limited to four batches. Some thought was given to moving the batching plant as the paver worked away from the present location but the contractor has concluded it is cheaper to add trucks as the distance from the mixer to plant increases. Nine trucks were used when the haul was seven miles. The longest haul will be about eleven miles.

Preparing subgrade requires only light work with slips. A tandem roller is used between the forms. A 21-E paver pours one-half of the pavement for about 21 days, or until the concrete sets sufficiently to allow the mixer and trucks to operate on it, and then it pours the other half. Turnouts are placed as frequently as possible to reduce the distance the trucks must back to the paver.

The alignment contains many curves that are not well adapted to mechanical finishing. Instead two screeds are used weighing 15 lb. per foot. These are followed by a float board, rubber belting and a broom finish. The pavement is covered with straw and kept wet for ten days. Logs are placed on the straw to keep vehicles from using the newly laid pavement. The work is being done by Connor Bros., Brooklyn, N. Y., with Peter Connor and John Hann in charge.

Unique Sewage Plan for North Toronto

An activated-sludge plant, to treat pre-settled sewage, has been recommended for North Toronto, Ont., by Dr. G. G. Nasmith, of Gore, Nasmith & Story, consulting engineers, Toronto, and Harrison P. Eddy, consulting engineer, Boston, Mass. The sludge from both the pre-settling tanks and the activated-sludge plant would be heated, digested in tanks, and dewatered on glass-covered drying beds. Works large enough to heat a dry-weather flow of 6 U. S. m.g.d. from 50,000 people are advised, but in times of storm the ultimate operating rate would be 12 U. S. m.g.d., besides which there would be standby sedimentation tanks to take the excess 36 times the dry-weather flow, or 216 U. S. m.g.d. The estimated construction cost is $576,000 or $96,000 per U. S. m.g.d. capacity. The total annual charges are estimated at $77,243 or about $35 per U. S. m.g.d., allowing 5 per cent interest and 1.733 per cent depreciation (30-yr. life, 4 per cent sinking fund). More detailed figures are given in *The Canadian Engineer*, Aug. 3, 1926.

Percentage Renewals and Average Life of Railway Ties

Studies of Records of 127,500 Treated and Untreated Test Ties Support Use of Law of Probability—Charts Show Average Life and Probable Remaining Life at Any Given Period

By J. D. MacLean

Engineer in Forest Products, U. S. Forest Products Laboratory, Madison, Wis.

FOR a number of years the Forest Products Laboratory, in co-operation with the railroads, has been collecting tie-service records from test sections of track in various parts of the country. These records comprise both treated and untreated ties of different species. Inspections are made at regular intervals (usually annually) after the ties are placed in service and renewals started. When all the ties in a test section have been removed, the average life of the ties in the group is computed.

Obviously the average life will vary widely for different groups. Nevertheless, throughout all of the groups there is a remarkably constant correlation between the proportion of renewals made and the corresponding elapsed proportion of the average life. To illustrate, in a group of ties having an average life of 12 years, about 22 per cent would be renewed in 9 years, and in another group having an average life of 8 years about 22 per cent would be renewed in 6 years, or at 75 per cent of the average life in each case.

Renewal Curves — Several years ago the Curve *A* in Fig. 1 was prepared by M. E. Thorne, showing the percentage of tie renewals plotted against percentage of average life elapsed (see "Proceedings" of the American Wood Preservers Association, 1918). This graph takes the form of the "cumulative frequency" or "summation" curve derived from the familiar probability type, and is based on completed service test records of 12,185 untreated ties from 26 groups, and 30,751 treated ties from 17 groups, or 42,936 ties in all. A number of railroads in using this curve have found that it indicates very closely the relation between renewals and average life of ties in their own practice, especially when the number of ties involved is fairly large.

Since the preparation of this curve, a large number of other service tests have been completed, and curves based upon these indicate clearly the operation of the law of probability in the replacement required annually. The additional records include 44,970 untreated and 39,646 treated ties, making a total of 57,155 and 70,397 respectively, or a grand total of 127,552 ties. There were 58 different groups of untreated and 37 groups of treated ties, or 95 records altogether. The records, which include renewals for all causes, are probably the most extensive thus far obtained from the standpoint of numbers, distribution, and reliability. An effort was made to eliminate all data not considered entirely reliable.

For each group of ties the average life, the percentage of renewals, and the percentage of average life elapsed at each renewal period were computed. Curves were drawn for the individual groups, showing the relation between the total percentage of tie renewals and the percentage of average life elapsed. Readings were then taken from each of the curves (for definite percentages of renewals) and a weighted average value of percentage of average life elapsed was computed. Weighted averages were determined for untreated ties alone, treated ties alone, and for all ties including both treated and untreated. The data thus obtained are shown in the accompanying table.

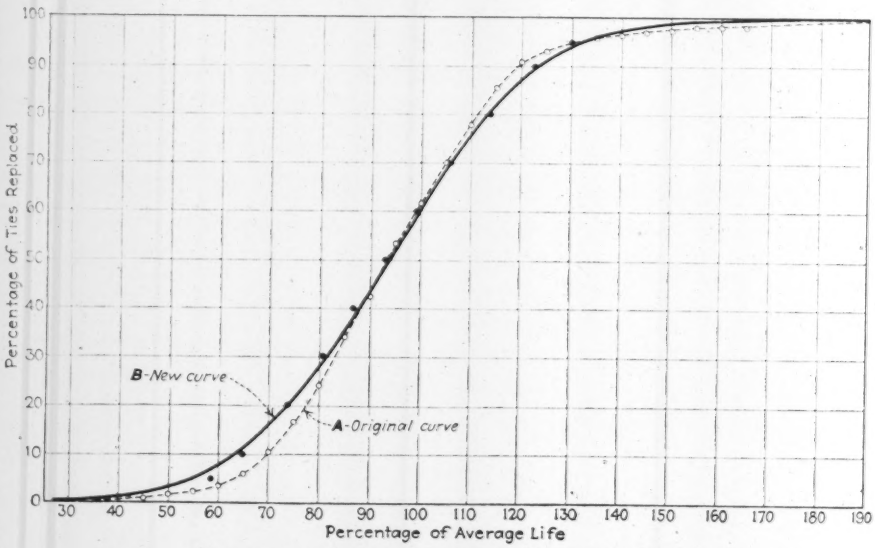


FIG. 1—COMPARISON OF TIE RENEWAL CURVES
A, Original curve based on records of 42,936 ties. B, New curve based on records of 127,552 ties.

Summation Curves—The information given in this table is plotted in Figs. 1 and 2. Fig. 1 shows both the original curve, *A*, mentioned above and the corresponding new curve, *B*, derived from the more complete data on 127,552 ties. It will be observed that the results indicated by the former are fairly well checked, over the more important range, by the latter curve.

Fig. 2 shows the summation data of the table plotted on "probability" paper. This paper is so constructed that when data which vary in accordance with the normal law of probability are plotted in the summation form as functions of their probability of occurrence, the points will lie on a straight line. With the data thus plotted it is possible to extend the curve and study the results that may be expected beyond the range over which data are obtained. It is also more convenient

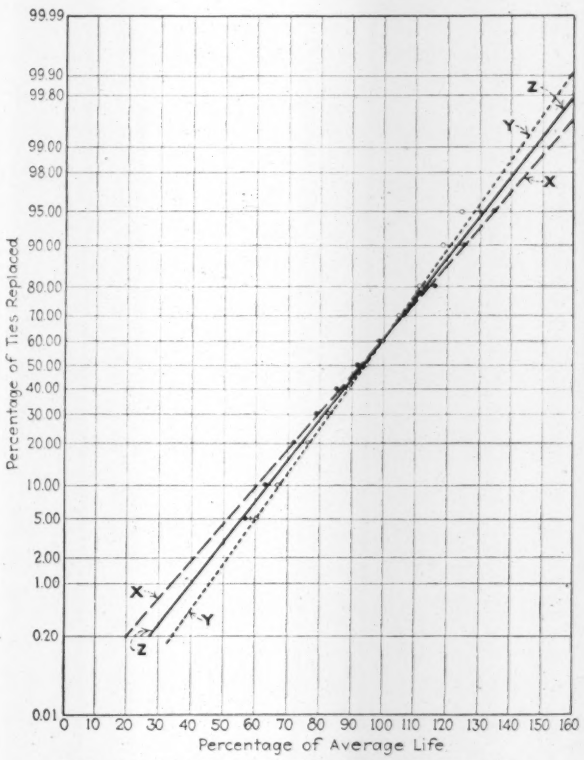


FIG. 2—RELATION OF TIE REPLACEMENT TO AVERAGE LIFE

Curve *X* for 70,397 treated ties. Curve *Y* for 57,155 untreated ties. Curve *Z* for all the 127,552 ties.

to us the straight line than the curve plotted on rectangular co-ordinate paper, as in Fig. 1, especially at the upper and lower limits.

Separate and Combined Curves—There is apparently some difference in the relation of renewals to average life for the treated and untreated ties, shown in Fig. 2, more particularly in the range where the renewals are small. In the more important working range, however, the difference is only slight. It is possible that the variation arises on account of decay being the more important influence affecting renewals of untreated ties, whereas mechanical wear is the more potent factor with treated ties. In any event the small difference in the two curves makes it possible to employ a combined curve with sufficient accuracy.

In the combined curve for all 127,552 ties the points fall practically along a straight line through the co-ordinate point representing 50 per cent renewals and 94 per cent of average life. The results are strikingly close to a true probability relation, as proved by the fact that a straight line can be drawn through a majority of the plotted points.

By extending the line of the combined curve it will be found to intersect the horizontal top line (99.99 per cent replacements) at about 181 per cent of the average life. In other words, practically all ties are replaced when about 181 per cent of the average life has elapsed. Computations made from the data to determine the percentage of average life at which all ties were removed gave about 180 per cent, which checks the curve very closely. An examination of the lower end of the combined curve shows that nearly 40 per cent of the computed average life elapses before 1 per cent of the ties are replaced. Renewals then become more frequent, reaching a maximum rate between 90 and 100 per cent of the average life.

Use of Curve Diagram—The following example will illustrate the use of the single straight-line combined graph. Assume that in a homogeneous group of ties, all placed in service at the same time, 25 per cent have been removed in six years. Using the graph, it will be noted that 25 per cent would normally be removed when about 78 per cent of the average life has elapsed. Hence six years is 78 per cent of the average life to be expected, which is thus figured at about 7.7 years.

If it is assumed that the group contained 1,500 ties and it is desired to estimate the removals expected during the succeeding year, take seven years as a percentage of 7.7 years, the average life. The result is 91 per cent, and the curve shows that a total of 45 per cent or 675 ties will have been replaced at that period. Renew-

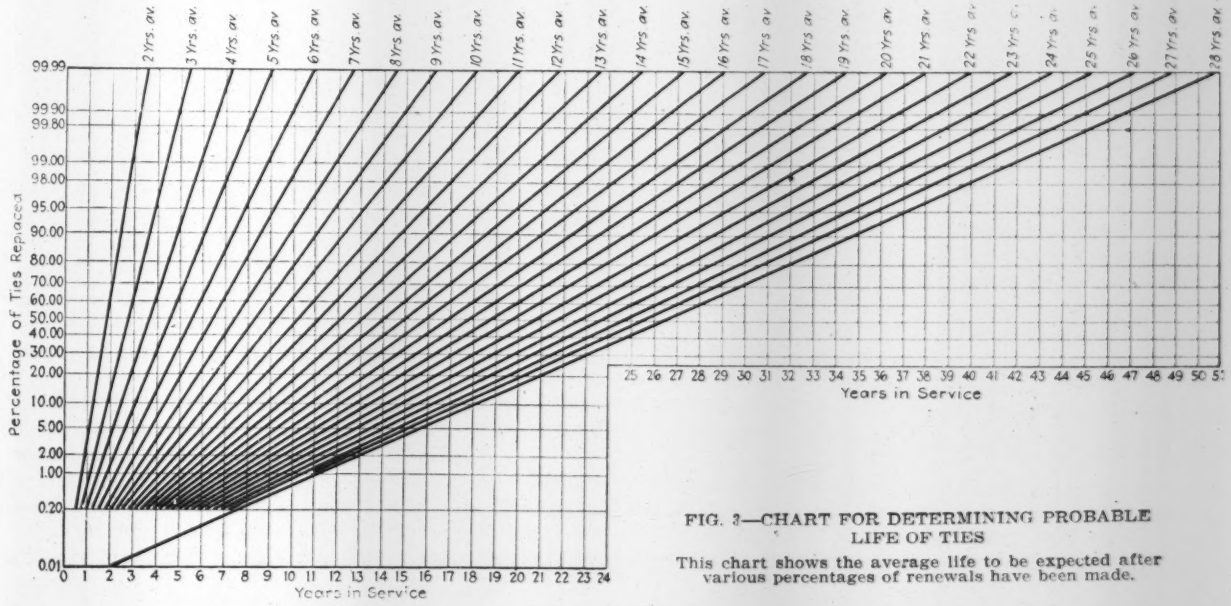


FIG. 3—CHART FOR DETERMINING PROBABLE LIFE OF TIES

This chart shows the average life to be expected after various percentages of renewals have been made.

als to be expected during the seventh year, therefore, amount to 300 ties. The renewals for subsequent years can be readily computed in the same manner.

If in the above case the curve for untreated ties had been used, the computed average life would have been about 7.5 years. The curve for treated ties would have given about 7.8 years. In either case the variations from the figures obtained by using the combined curve would be less than 3 per cent. Since the graph is based on extensive data from test groups of ties placed in many different sections of the country and under widely varying traffic conditions, it is felt that it furnishes a reliable guide for estimating the average life and the rate of tie renewals when the group of ties under consideration is large enough to be representative.

Chart for Simplified Computation—In order to avoid the computations necessary in using the curves shown in Figs. 1 and 2, the chart Fig. 3 has been prepared, which is based on the curve for all ties in Fig. 2. Probability paper was used for this chart also. However, in this case definite average life values were assumed and the percentage of ties replaced (corresponding to different proportions of the average life) was plotted against years in service instead of percentage of average life, as in Fig. 2. The diagonal lines are marked with the average life to be expected for various percentages of replacements after a given period of years in service.

Method of Using Chart—The previous example will illustrate the use of this chart. For a group of ties, 25 per cent are assumed to be removed after six years. The horizontal line representing 25 per cent replacements intersects the vertical six-year line at about seven-tenths of the horizontal distance between two diagonals, one representing seven and the other eight years average life. The point of intersection, therefore, represents an average life of 7.7 years, checking the value previously determined from Fig. 2.

To determine subsequent renewals, let it be assumed again that there are 1,500 ties in the group and that 25 per cent are removed after six years service. The total percentage of renewals to be expected by the end of the seventh year can be found by reading upwards on the seven-year line to a point about 0.7 of the horizontal distance between the diagonals representing an average life of seven and eight years, respectively. This is about 45 per cent, or a total of 675 ties, checking the result found previously from Fig. 2. Then 675 less 375 gives 300, the number to be replaced during the seventh year. Likewise, reading up the line of eight years service to a point 0.7 of the horizontal distance between the seven- and eight-year average life diagonals, it is found that about 65 per cent, or 975 ties, are removed by that time. Similarly, it will be found that a total of about 84 per cent or 1,260 are removed in nine years. The time at which practically all ties are out can be determined by reading on the horizontal scale directly below the point on the top line taken 0.7 the distance between the seven- and eight-year diagonals. Projecting from this point to the lower scale it will be found that practically all ties of this group, having a computed average life of 7.7 years, would be removed in slightly over 13.9 years, or approximately fourteen years.

Frequency Curve—If a frequency curve (showing percentages of ties removed at successive time intervals) is plotted from the combined data with the origin of co-ordinates of the curve at 100 per cent average life, as at the left in Fig. 4, a certain degree of positive skewness will be found. This is because more than 50 per cent of the ties have been replaced before 100 per cent of the average life is reached, as already indicated by the cumulative curve in Fig. 2. It is very likely that the following are factors of track maintenance which tend to produce skewness of the curve with respect to the origin taken at 100 per cent of the computed average life:

(A) In the early removals, consideration of economy may make it desirable to remove a certain number of ties that would normally be serviceable for a longer period.

(B) When a large proportion of the ties have been replaced, those surviving have no noteworthy influence on the track conditions. For that reason some of them

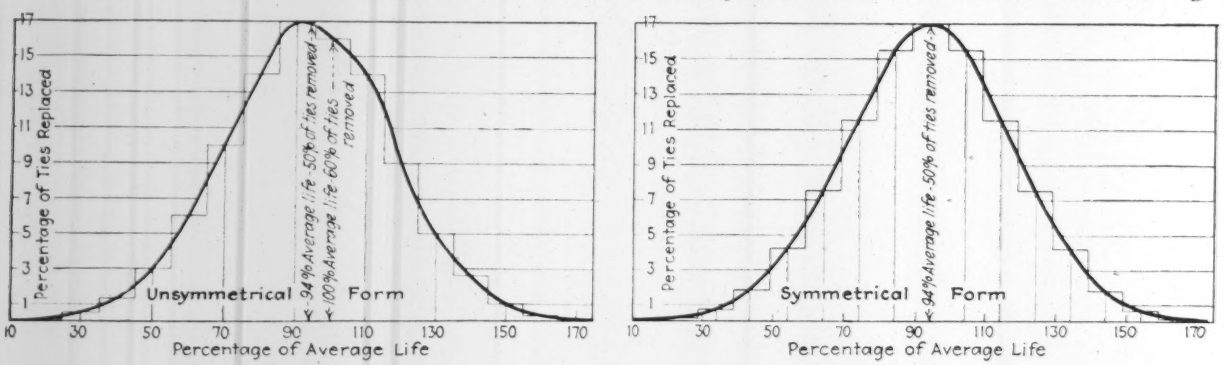

Percentage of Ties Replaced
Unsymmetrical Form
94% Average life-50% of ties removed
100% Average life-60% of ties removed
Percentage of Average Life
Symmetrical Form
94% Average life-50% of ties removed

FIG. 4—FREQUENCY CURVES FOR TIE REPLACEMENTS

These curves show successive percentages of the replacements for 10 per cent intervals of average life. The curve at the left is of unsymmetrical form, with origin taken at 100 per cent average life. The curve at the right is of symmetrical form, with origin taken at 94 per cent average life.

DATA FOR CUMULATIVE FREQUENCY CURVES

Untreated — 57,155 Ties Percentage		Treated — 70,397 Ties Percentage		Treated and Untreated Combined 127,552 Ties Percentage		Percentage Average Life from Line Z-Z; Fig. 2
Of Renewals	Of Average Life	Of Renewals	Of Average Life	Of Renewals	Of Average Life	
5	60.9	5	56.7	5	58.5	55.0
10	67.3	10	63.1	10	64.8	63.8
20	76.3	20	72.1	20	73.9	73.6
30	82.7	30	79.3	30	80.7	81.5
40	88.8	40	85.3	40	86.8	88.0
50	94.5	50	91.9	50	93.1	94.0
60	99.9	60	98.8	60	99.2	100.0
70	105.6	70	106.5	70	106.0	106.0
80	111.7	80	116.0	80	114.1	113.5
90	119.1	90	125.7	90	122.7	123.5
95	124.5	95	134.5	95	130.0	132.0

may be left in service a considerably longer time than would be permissible if ties of the same condition were present in large numbers. Even a few ties left in service several years longer than the majority of those in the group may have considerable weight toward increasing the computed average life. This would tend, of course, to produce an unsymmetrical frequency curve when the origin is taken at 100 per cent average life.

(C) Other factors which doubtless increase the early mortality of ties are fires, washouts, wrecks, etc.

To eliminate skewness in the graph, the origin may be taken at the "mode" (94 per cent average life) instead of the arithmetic mean (100 per cent average life). By this means a normal frequency curve applying correctly to the data will be obtained. Such a curve is given at the right in Fig. 4, which shows the rate of replacements for 10 per cent intervals of average life. The renewals for successive 10 per cent intervals are represented by rectangles, and a smooth curve is drawn through the midpoints. It will be noted that between 29 and 39 per cent of the average life only 0.70 per cent of the ties are removed, whereas between 89 and 99 per cent of the average life (the period of maximum replacements) 17 per cent are removed.

In the equation for the symmetrical form of the frequency curve in Fig. 4 as given below Y represents the frequency or percentage of replacements for a given value x; x is the distance to the right or left of the origin measured in intervals of 10 per cent average life for the group considered; e is the base of the Naperian system of logarithms.

$$Y = 17e^{-\frac{x^2}{1.98}}$$

General Considerations—In the use of all the foregoing curves the following considerations should be borne in mind: (1) The larger and more homogeneous the group of ties under consideration, the greater the likelihood that the curve of renewals will closely represent the results that will be obtained. (2) When the number of renewals is very small, the average life estimated from the curves will not be as reliable as that indicated when larger proportions of renewals have been made. When, however, the number involved is sufficient to furnish a representative sample, the chart or curves provide a means of closely estimating the rate of renewals and average life to be expected, which will hold for groups of ties having either a long or a short average life.

Struggles of Small Town with Large Sewage Problem

Austin, Minn., After Strenuous Controversy Over Direct Oxidation Decides on Imhoff Tank and Sprinkling Filters—Packing House Waste Receives Partial Separate Treatment

By Frederic Bass

Consulting Engineer, Professor of Municipal and Sanitary Engineering, University of Minnesota, Minneapolis

COMPLETION of Imhoff tanks and sprinkling filters for Austin, Min., affords occasion for an article showing how a relatively small community with a dominating industrial plant finally solved its sewage disposal problem, the various steps in the process, the number of engineers employed successively, and the part played by the State Board of Health, first in a local publicity campaign and later in sidetracking a proposed contract for a proprietary process by stating clearly and forcibly that although it lacked authority to refuse a permit for a plant that would probably do the required work, yet it was convinced that equal results could be obtained at less cost.

Austin, with a population of approximately 12,000 persons, is situated on the Cedar River, 15 miles north of the Minnesota-Iowa boundary. Besides the usual characteristics of a small city in a rich agricultural region it contains the Hormel packing plant, which furnishes employment to nearly 2,000 persons, one-sixth of the total population, and double the number employed five years ago. The Cedar River flows southerly to and through eastern Iowa to the Mississippi; at Austin it has a drainage area of about 400 sq.mi. with a runoff from zero to over 5,000 sec.-ft.

Complaints, Investigation, Publicity Work—Complaints of the nuisance caused by the discharge of sewage and waste into Cedar River have been made for many years at periods of low water. In July, 1919, the Minnesota State Board of Health was requested by the health officer of Austin to investigate the situation. This board made a report in January, 1920, and its Division of Sanitation prepared a series of 18 articles on the subject of stream pollution and sewage disposal which were run serially in the Austin *Herald*. As a result, the city employed John Wilson, consulting engineer, Duluth, to make a report on the needs of the city. In October, 1920, he recommended an experimental disposal plant. In May, 1921, the city bought a site for a plant of about 35 acres near its southern boundary. In the following October, an amendment to the city charter was voted which gave to the city council the authority to issue sewage disposal bonds. About the same time a contract was let for the construction of a 42-in. intercepting sewer along the river to the disposal site. In November, 1922, Pearse, Greeley & Hansen, consulting engineers, Chicago, made a report on a proposed method of investigation of the situation, followed by a report, January, 1923, recommending a plant of the Imhoff-percolating filter type.

Direct-Oxidation Episode—In May, 1923, A. B. Overland, city engineer of Austin, returned from an eastern trip on which he had observed the direct-oxidation plant at Allentown, Pa. He wrote to the State Board of Health indicating his interest in this method. In August preliminary plans for this type of plant were submitted to the State Board of Health for approval, which was withheld until further information could be obtained by its Division of Sanitation. Within the next month, H. A. Whittaker, director of the Division of Sanitation, and J. A. Childs, engineer, visited the direct-oxidation plants of the cities of Allentown, Pa., and Phillipsburg, N. J., the old experimental plant at Elmhurst, N. Y., and the demonstration plant at Toronto, then under test by the Provincial Board of Health of Ontario. About the same time a committee of the city council made a similar trip. In October

the city council appointed a committee with power to contract for a direct-oxidation plant.

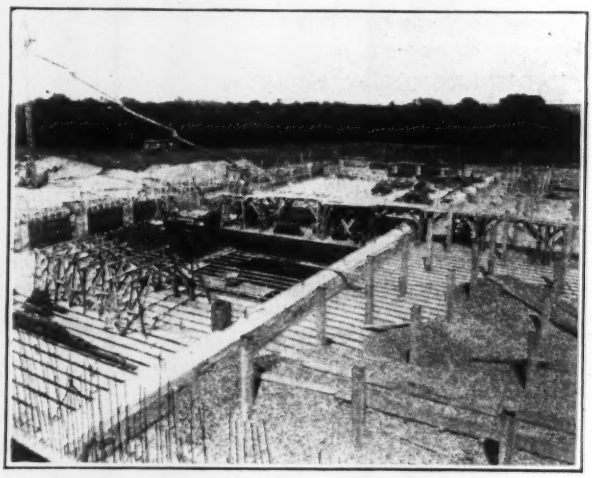
The city council was notified of a meeting of the State Board of Health held Nov. 6, 1923, at which consideration would be given to the process proposed to be used by the city. The proposal made to the city by the promoters of the direct-oxidation process was presented at this meeting and contained the following

COVERED IMHOFF TANKS AND SPRINKLING FILTERS, AUSTIN, MINN.
Sludge flows to drying bed by gravity from the Imhoff tanks.

items: The consideration for the plant was to be $280,000. It was guaranteed to be able to treat 2 m.g.d. of combined city sewage and packing house waste, to operate without aerial nuisance, to meet the approval of the State Board of Health, to require not over 2,400 lb. of lime per m.g. of sewage, to use not over 60 gal. of fuel oil per 1 m.g. of sewage for drying sludge and to require a gross operating expense of not over $30,000 annually for 2 m.g.d. of sewage. An arbitration board was provided for in case of dispute. The city was to operate under a license and to employ its own operator.

Recommendations of State Health Board—The State Board of Health recommended in addition that the city include the following requirements for the effluent: Biochemical Oxygen Demand: That the average 5-day biochemical oxygen demand of 50 consecutive samples shall at no time exceed 20 p.p.m. No single sample shall exceed 40 p.p.m. The dilution method shall be used. Suspended Matter: That the average of 50 samples shall not exceed 50 p.p.m., and no one sample exceed 75 p.p.m. The Gooch crucible method shall be used. Settleable Solids: The average of 50 samples shall not exceed 0.1 c.c. per liter, no one sample shall exceed 0.5 c.c. per liter. Dissolved Oxygen: The average of 50 samples shall not be less than 5 p.p.m. and no single sample shall contain less than 2 p.p.m. Not over two samples shall be taken in one day, with an interval of not less than 4 hr. and not more than 10 days. At the same meeting the State Board of Health passed a lengthy resolution of qualified approval and warning protest that had been formulated after considerable laboratory work by the staff of the Division of Sanitation. This resolution, as also later action in granting a permit, with specific denial of approval of the direct-oxidation process, was summarized in *Engineering News-Record*, Dec. 13, 1923, p. 993, and commented on editorially on p. 959 of the same issue. The concluding part of the resolution is here given in full:

> The obligation of the State Board of Health in matters of this kind is in a sense two-fold. The first is the protection of the interests of riparian owners affected by the nuisance including those living outside of the city limits as well as those living inside of the boundaries of the city. The second is to determine, and to advise the city, as definitely as the available information will permit, whether the contemplated sewage treatment works will relieve the existing unsatisfactory conditions, and whether the proposed improvement is capable of taking care of unsatisfactory conditions which may arise in the future which may be caused by an increased strength or volume of sewage, or both, and whether the treatment works under consideration can be extended or added to to take care of such conditions in the future. The attorney general is of the opinion that approval could not be legally withheld for plans of sewage treatment works which admittedly should relieve the present unsatisfactory conditions on the grounds that it might be difficult to extend or add to the treatment works so as to relieve satisfactorily a bad condition in the future which may be due to increased volumes or strength of sewage, or both.
>
> THEREFORE, Be it Resolved: That if the City of Austin, with full knowledge of the above facts, is desirous of proceeding with the installation of a chemical precipitation plant and showing in detail the location of all machinery, tanks, pipes, valves, flumes, and other appurtenances and apparatus, these plans will receive consideration by this Board, and if found to be satisfactory as to the principles involved, will be approved as a means of relieving the unsatisfactory conditions existing at the present time. Objection cannot legally be made by this board to the use of the electrolizers employed in the so-called direct-oxidation process inasmuch as the use of this apparatus does not in its opinion interfere with the principles of chemical precipitation. It must be clearly understood that these electrolizers cannot be considered as more than devices for additional mixing of the lime with the sewage until it can be demonstrated to the satisfaction of this board that the electrolytic portion of the process is of material value in the treatment of sewage.

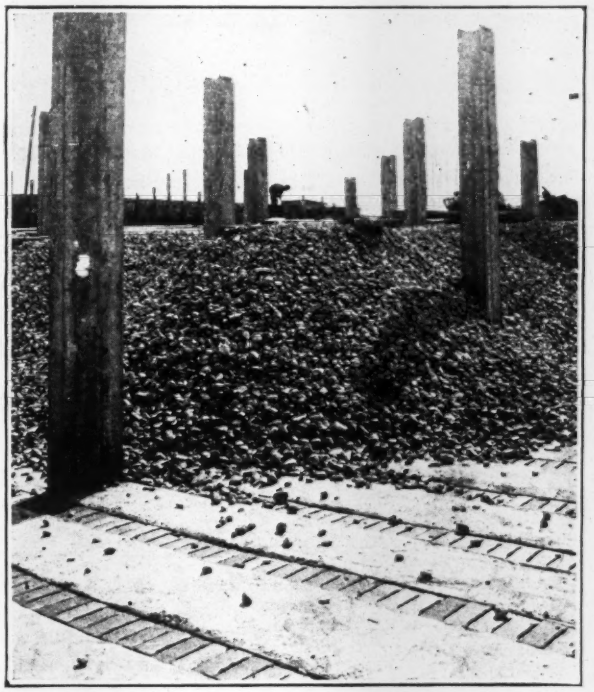


AUSTIN SPRINKLING FILTERS UNDER CONSTRUCTION
Concrete was made outside the site, chuted to a batch hopper on the end of an elevated runway, then wheeled to place.

No time was lost by the city in accepting the opportunity thus afforded, for ten days later (Nov. 16) complete plans of the proposed direct-oxidation plant were submitted to the State Board of Health. The report on these plans made by the Division of Sanitation to the board contained the following statements: "These plans are recommended for approval as a chemical precipitation plant in accordance with the instructions

and reservations of the State Board of Health as stated in the resolution relative to this matter, adopted Nov. 6. Nothing in this report shall be construed in any way as an approval or endorsement by the State Board of Health of the electrolytic sewage treatment process."

On Nov. 20 the city council held a somewhat stormy meeting at which it was generally expected that a contract for construction of the plant would be ordered, but instead the contract was rejected. The State Board of Health had been instructed by the attorney general that it could not withhold approval of any plans which offered a plant which would improve conditions, no matter what the cost might be. The board accordingly approved the plans but in such a manner as to place the weight of responsibility for deficiency or failure of the plant upon the shoulders of the city council. This, together with the fact that the company offered only a $20,000 security bond in support of the guarantee, led to the rejection of the scheme. The Minnesota State Board of Health, with no power to prohibit the use of a type of plant which it apparently felt to be inferior, succeeded in handling the situation to its satisfaction by an accomplished diplomacy.



PLACING STONE IN AUSTIN SPRINKLING FILTERS
Specially contructed vitrified tile underdrains are placed at intervals of 27 in.

The cost of this plant was to have been defrayed to the extent of $85,000 by the Hormel Packing Co., although the packing house waste had a volume of approximately 1 m.g.d. and the city sewage had about the same. The biochemical oxygen demand of the packing house waste was, however, about six times that of the city sewage. It was reported that the company felt that since it was a large taxpayer and since it gave employment to large numbers of people in the city it was entitled to assistance from the city in the disposal of its waste.

Works as Built—In the Spring of 1924 complaints made by Iowa citizens to the Iowa Department of Health led the latter to place the matter in the hands of the legal department of the state. Knowledge of this situation transmitted to the Minnesota State Board of Health was referred to the city council of Austin. An entire new council and a new mayor then addressed themselves to the task and in July, 1924, employed the writer to design a 1.33-m.g.d. plant for the disposal of the city sewage only. Plans and specifications were completed by Sept. 1 and on Sept. 16 a contract for the construction of a pumping station and Imhoff tank-percolating filter plant was let for $219,000. The plant has been completed and is now in operation. The final total cost was $220,000.

The intercepting sewer arrives at the site of the plant with its invert at El. 13, while the surface of the water in the river is normally about 20 with occasional rises to 28 and possibly to 30 or more. The pumping station is of concrete, 37x27 ft. in plan and 29 ft. deep below ground. In it are three 8-in. centrifugal pumps directly connected to electric motors, automatically operated by float mechanism. There is also an 18-in. pump to take care of the ordinary storm-water flow which enters the sewer system in a part of the city area. The pump pit is surmounted by a masonry house which contains an office and laboratory.

About 300 ft. of 12-in. cast-iron force main delivers the sewage to the disposal plant, which consists, successively of Imhoff tanks, a dosing tank, a percolating filter and a Dorr clarifier or final settling tank, besides which there is a sludge-drying bed, to which sludge from the Imhoff tanks flows by gravity.

Imhoff Tanks—There are two reversible-flow Imhoff tanks, each 87x26½ ft. in plan and 27½ ft. deep below the water level. In the upper or settling compartment there is an average detention period of 1½ hr., and the sludge compartment below has a capacity of approximately 30,000 cu.ft. in each tank. The dosing tank, with an average detention period of 20 minutes, is 41⅔x20 ft. in plan and from 4 to 6 ft. in depth. A 24-in. automatic siphon carries the sewage to the filter.

Sprinkling Filter—The filter is 229x178 ft. in plan, and the filtering material, which is of 1.5 to 3-in. screened broken stone, is from 7⅔ to 8⅔ ft. in depth. The sewage is carried from the dosing tank through the siphon to a 24-in. vitrified pipe running the length of the filter. From this central pipe, twenty-nine 8-in. vitrified pipe laterals extend to the sides of the filter. On each lateral there are six risers, on top of which, 6 in. above the surface of the stone, there are set sprinklers. In plan, the sprinklers are at the apexes of equilateral triangles 16 ft. on a side. After being sprayed over the surface of the stone, the sewage gradually percolates to the bottom, where especially constructed vitrified tile underdrains are placed in a concrete bottom at intervals of 27 in. These underdrains conduct the now oxidized sewage to side channels which in turn conduct it to a final settling tank 32 ft. in diameter and having an extreme depth at the center of 7⅓ ft. In this tank there is set a Dorr clarifier, whose four revolving radial arms are in contact with the bottom of the tank and make one revolution in about 30 minutes. By means of inclined shoes attached to these arms the sediment or sludge in the filter effluent is scraped to the center where there is a sump from which

the sludge is pumped back through a 3-in. cast-iron pipe to the Imhoff tanks. The effluent from the final settling tanks flows over weirs to a collecting channel and flows directly to the river through a 24-in. vitrified pipe.

The Imhoff tanks, the filter and the final settling tank are all surmounted by superstructures to protect against cold weather and freezing. This housing is of wood frame construction with an exterior finish of portland cement stucco on metal lath. The interior is lined with ceiling to add warmth and to prevent condensation on the interior side of the stucco which otherwise would be exposed. Previous experience with structural steel framing led the designer to substitute the wood. Corrosion of steel is extremely rapid in the atmosphere of such buildings.

Sludge-Drying Bed—The sludge from the lower compartment of the Imhoff tanks flows by gravity to a 160x100-ft. sludge-drying bed about 2 ft. deep, the drainage from which goes to the river. The dried sludge will be stored on the surface of the ground. Experience has shown that farmers are eager to haul it away as it has considerable value locally as a fertilizer.

Packing Company Clarifier—In the summer of 1925, the Hormel Packing Co. constructed a 45-ft. Dorr clarifier to treat its waste and was given access to a city sewer emptying into the Cedar River in the heart of the city. Further treatment of this effluent will undoubtedly be necessary within a short period in order to prevent a nuisance.

In the preparation of this article the writer acknowledges the assistance given by Messrs. Whittaker and Childs of the Division of Sanitation, Minnesota State Board of Health and of C. H. Skinner of the Austin *Herald*. Phil Smith, city engineer of Austin, was in direct charge of construction of the plant from October, 1924, to April, 1925, and G. L. Brown, city engineer, from April to December, 1925, when the plant was placed in successful operation.

Double Filtration for Part of London Water

A double filtration plant, with emergency chlorination apparatus, for a part of the London, England, metropolitan water supply was opened on July 19. The plant, which is located at Walton-on-Thames, has a present capacity of 22.5 U. S. m.g.d., but will have an ultimate capacity of 42 U. S. m.g.d. There are 18 primary rapid filter units, each with a capacity, as reported by the London *Surveyor* of July 23, of from 1.2 to 2.4 U. S. m.g.d. when operating at the rate of 120 to 240 U. S. g. per sq.ft. per hr. (about 125 to 250 U. S. m.g.d. per acre). There are 6 secondary, slow sand filters, each with an area of about five-sixths of an acre or five acres altogether, giving an operating rate of 4.5 U. S. m.g.d. per acre. Four sedimentation tanks receive the water used in washing the sand from both primary and secondary filters, three for the former and one for the latter. Of the rapid filters, the apparatus for 8 units was supplied by the Paterson Engineering Co., and of 10 by the Candy Filter Co., both of London. Decision to use the rapid sand filters seems to have been based, partly, upon the successful operation of rapid sand filters installed by the Metropolitan Water Board in 1923 at Barns Elms for the purpose of test, and to increase the rate of filtration on the existing slow sand beds there. Henry E. Stilgoe is chief engineer of the London Metropolitan Water Board.

Curved Arch Spans in Long Concrete Bridge

Sharp Turn in Recently Opened Bridge Over Mohawk at Schenectady Is Carried by Two Arches Curved in Plan

By C. H. Wood
Senior Assistant Engineer, Department of State Engineer and Surveyor, Albany, N. Y.

Some remarkable structural features are contained in the great concrete arch bridge over the Mohawk River between Schenectady and Scotia, N. Y., opened to traffic some months ago. Most interesting is the manner in which the bridge is carried around a curve of about 54 deg., near one end of its length. Two consecutive spans are built on curved alignment, as brought out clearly in the photographs, Figs. 2 and 3, and the sketch plan, Fig. 1. The Barge Canal crossing of the bridge, at about mid-length, represents recourse to steel in place of concrete, in order to reduce the weight and therefore the arch thrust. This span is an excellent example of steel rib construction covered with gunite.

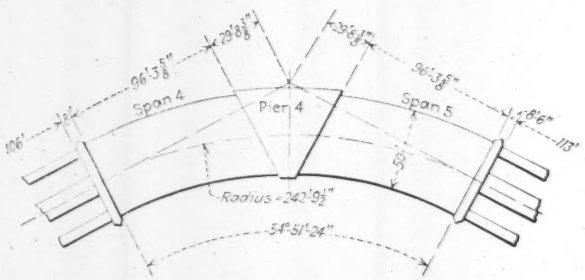


FIG. 1—SKETCH PLAN OF CURVED SPANS

It is also an interesting fact that this structure replaces one built on the site of an early bridge of Theodore Burr. Burr's bridge was built in 1806 to 1808, and consisted of four suspension spans of about 200 ft. each, with main tension members built up of eight thicknesses of heavy plank, carried on stone piers built on cribs. In 1835 the bridge was strengthened by building smaller piers at mid-span of each opening to support the wooden superstructure, and forty years later, when it burned down, it was replaced by a wrought-iron bridge now in turn replaced, but in another location, by the new concrete bridge, known as the "Great Western Gateway" bridge. The latter was formally dedicated in June, though opened to traffic about six months earlier. It took six years to build, and cost $2,500,000.

At the bridge site the Mohawk River is 3,000 ft. wide, and is divided into three channels by two islands, one of the channels being used as part of the New York State Barge Canal. Borings showed the subsoil to be silt overlying very fine sand, at most of the piers. The sand is so fine that it is easily mistaken for clay, but on microscopic examination is seen to be a true sand. All piers are supported on wooden piles driven to 20 to 30-ft. penetration. The bridge has a roadway 40 ft. wide and two sidewalks each 6 ft. wide and is 3,167 ft. between abutments, and consists of twenty-four spans, generally 120 ft. long. Four of the piers are anchor piers, two of them being the piers flanking the Barge Canal.

Of the twenty-four spans, 21 are concrete ribbed

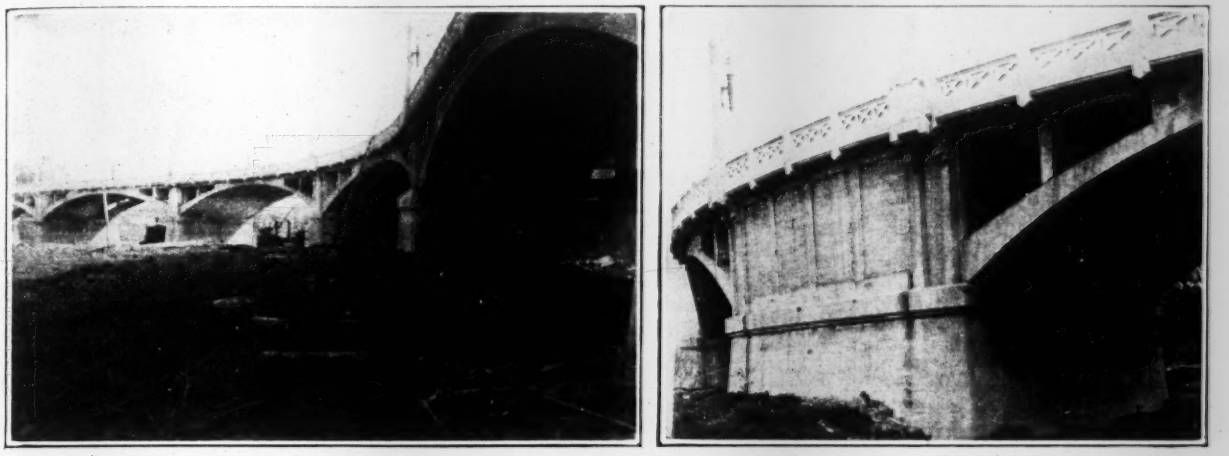


FIG. 2—CURVED CONCRETE ARCH SPANS OF WESTERN GATEWAY BRIDGE AT SCHENECTADY

arches, varying in length from 106 ft. to 120 ft.; two—the curved spans—are concrete barrel arches 96 ft. long, and one, the Barge Canal crossing, a three-hinged steel arch of six ribs covered with gunite, over 200 ft. long. The latter construction, the steel carrying structure of which is shown clearly in Fig. 3, was adopted for lightness, in order to reduce thrust on the channel piers.

The two curved spans constitute the chief remarkable features of the bridge. Of these two spans, each 96 ft. 3⅜ in. long between springing lines, and the wedge-shaped pier between them (see sketch, Fig. 1), the bridge swings through an angle of 54 deg. 51 min. 24 sec. on a radius of 242 ft. 9½ in. The arch barrels are monolithic concrete and are 50 ft. wide.

In the design of these curved spans no attempt was made to work out an exact mathematical analysis. The stresses were computed for a straight arch of the same span and rise and width. Under these conditions, the working stresses were kept about 25 per cent lower than in the other arches.

These curved arches have a rise of 13 ft., are 21 in. thick at the crown and 47½ in. thick at the skewbacks, and are 50 ft. wide. The longitudinal reinforcement consists of 1-in. square bars 12 in. on centers, in each face, while the transverse reinforcement consists of ½-in. square bars 18 in. on centers, in each face. The skewbacks were notched or sawtoothed in 5-ft. steps. The same expedient was used for the five spans at the west, or Scotia end, which have the rather unusual skew of 36 deg.

Another unusual feature is found in the eighth span from the Schenectady end which is on a 19-deg. skew.

The roadway has 1 per cent grade on the structure, and 4 per cent on the approaches. The floor slab is waterproofed with two-ply membrane waterproofing protected with 2 in. of concrete, on which a 2-in. asphalt block pavement is laid. The approach paving is dressed granite block, except for a small amount of concrete pavement. The asphalt block pavement and waterproofing protection have no expansion joints, except over the hinges of the steel span. The roadway slab

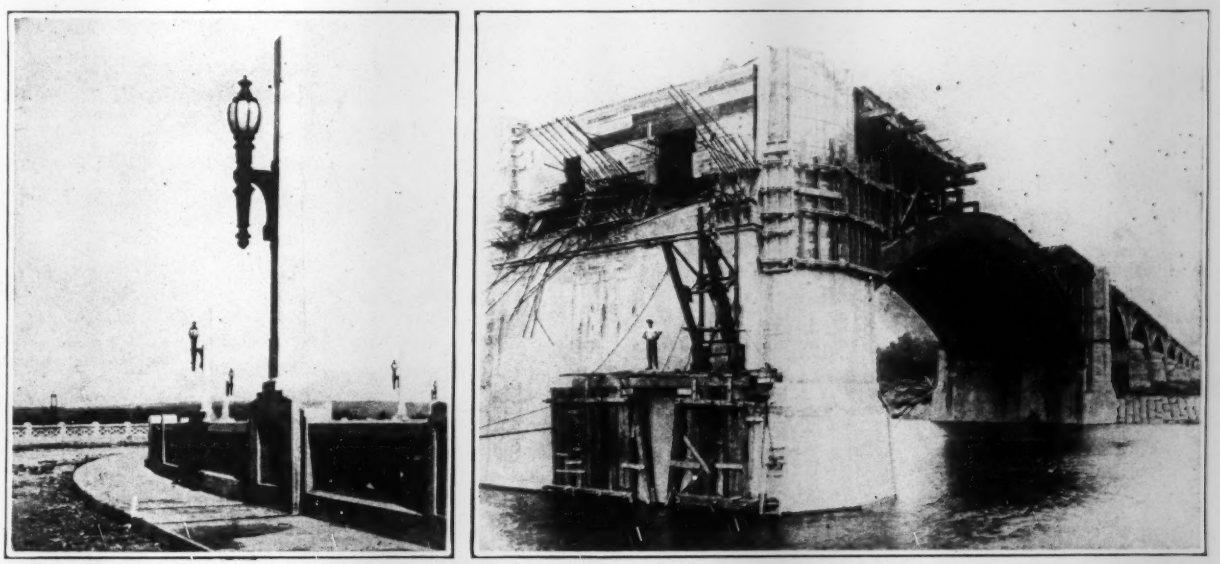


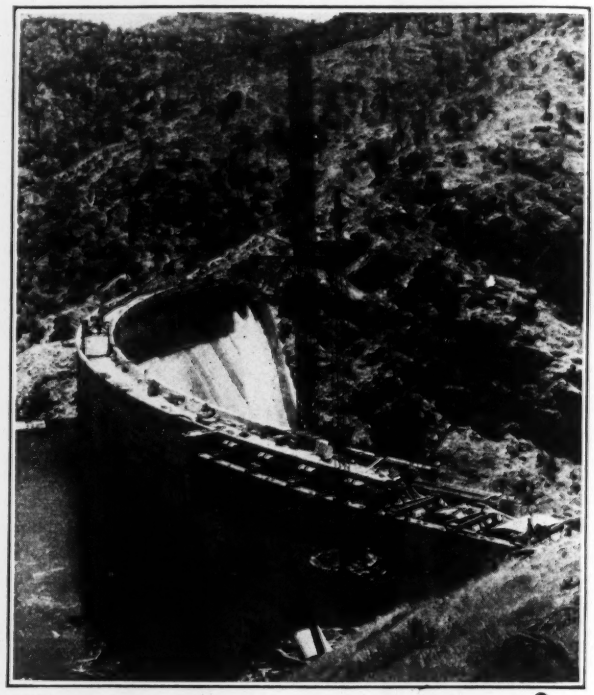
FIG. 3—SOME DETAILS OF THE SCHENECTADY-SCOTIA BRIDGE

Construction view of Barge Canal crossing—steel rib arches of 209½-ft. span later covered with gunite. At left: concrete and bronze lamp fixture.

itself, as well as the balustrade, has an expansion joint on either side of each pier and over the center hinge of the channel span.

Particular attention was paid to the lighting of the bridge roadway. A special bronze fixture, 7½ ft. high, over all, was designed, to be supported on a tapered concrete lamp-post (Fig. 3). Each fixture carries a luminous arc lamp for 6.6 ampere circuit. The bridge presents a beautiful appearance when lighted at night.

Design and construction of the bridge were under the state engineer and surveyor of New York, and were carried out by his staff. The work extended into the terms of three state engineers, Frank M. Williams, Dwight B. La Du, and R. G. Finch. The plans and specifications were prepared under the immediate direction of the writer. B. H. Davis was employed as consulting engineer on the first three of the four construction contracts. E. D. Hendricks, division engineer, was in charge of field work, with J. C. Bell and R. B. Smith successively as resident engineers.



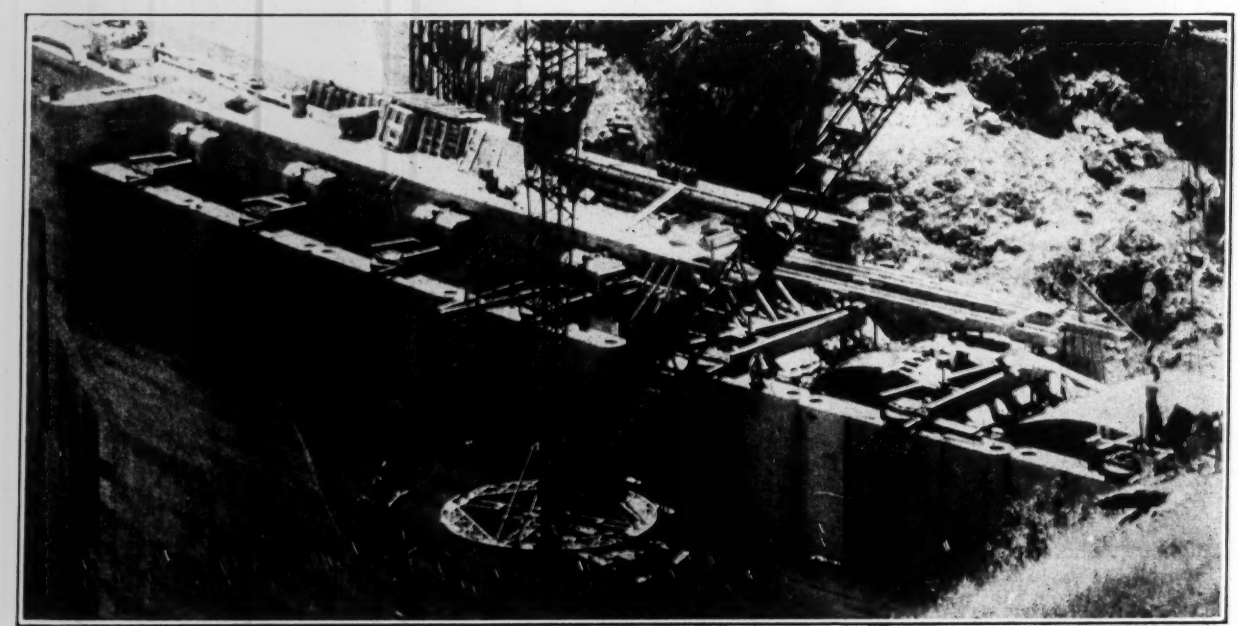
CONSTRUCTION VIEW OF EXCHEQUER SPILLWAY GATES, NORTH UNIT

Vertical Butterfly Gates on Exchequer Dam

Steel Gates, Made Up in 14 x 24-Ft. Units, Control Spillways on Recently Completed Dam in California

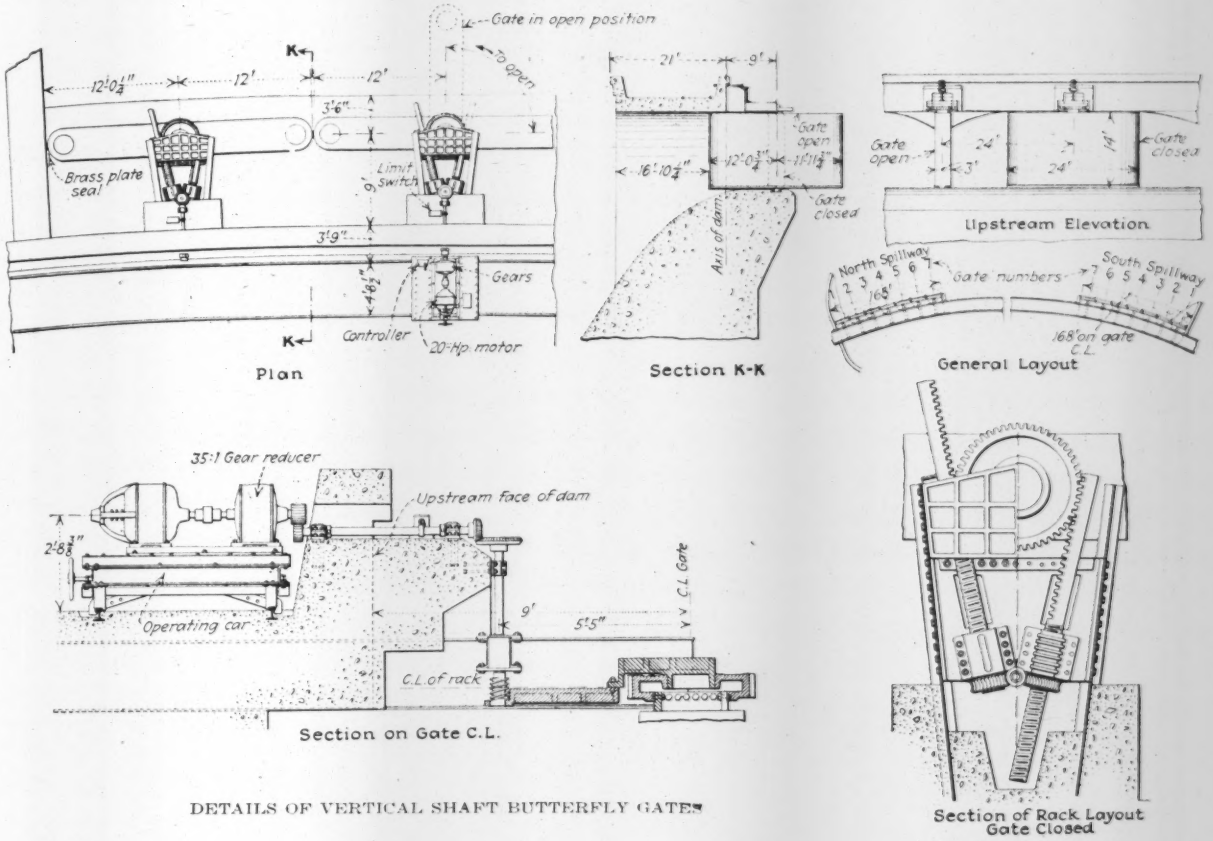
At each end of the recently completed Exchequer dam on the Merced River in California is a spillway, 168 ft. wide, which has been equipped with seven vertical-shaft, steel gates of the butterfly type. Gates of this type were selected because they made it possible to construct the dam with a thinner crest than would have been feasible with the more commonly used type of gate. Operation of the gates is effected by a 20-hp. motor mounted on a car which moves along the dam crest engaging the several gate-operating mechanisms successively. Details of the gate arrangement which, for the most part, were worked out expressly for this project are given in the following. The construction of the dam as a whole, which is to provide storage for the Merced Irrigation District, was described in *Engineering News-Record*, May 28, 1925, p. 880.

For handling floods in a river with a discharge of 75,000 sec.-ft. it was considered desirable to have the spillway crest as free as possible for the passage of drift of all kinds, including saw logs and uprooted trees. There was objection to the ordinary Tainter gate because of its forming, even when raised, an orifice



CLOSEUP OF GATES WHILE BEING ERECTED

through which the water must flow with the attendant possibility of obstruction by drift, whereas the weir type of spillway would permit the passage of drift with adjoining gates fitting against each other when the gates are in the closed position. Leakage between the gates is to be prevented by a brass strip fitted to one



DETAILS OF VERTICAL SHAFT BUTTERFLY GATES

less danger of clogging. Tainter gates when raised would interfere with the roadway that crosses on the dam and would make an unsightly projection. Moreover, the heavy unbalanced suspended weights that Tainter gates would have introduced were considered undesirable. The vertical shaft butterfly gate was therefore selected.

The gates are built up of structural steel consisting chiefly of $\frac{3}{8}$-in. plates and angles of suitable size and spacing. The gates are hollow except for the internal bracing and the hollow cast-steel shaft, 24 in. square and $2\frac{1}{2}$ in. thick, which extends through the center of the gate from top to bottom and fits over a pin of like material at the base. The outside dimensions of the gates are: Length, 24 ft., height, 14 ft., and thickness, 3 ft. To facilitate shipment the gates were made up in the shop in three pieces which were riveted together in the field. The weight of the rotating part of each gate is about 19 tons.

The baseplate is 3 ft. square and carries in its center a pin 16 in. in diameter which projects $5\frac{3}{8}$ in. into a socket on the vertical shaft of the gate. A similar arrangement at the top of the shaft holds the gate in place. The upper plate, however, instead of being embedded in concrete, is held in place by two 24-in., 80-lb. I-beams carried by the concrete of the roadway. There are no piers between the gates, the rounded ends of adjoining gates fitting against each other when the gates are in the closed position. Leakage between the gates is to be prevented by a brass strip fitted to one end of each gate and arranged so that the spring is pressed tightly against the adjoining gate when in the closed position.

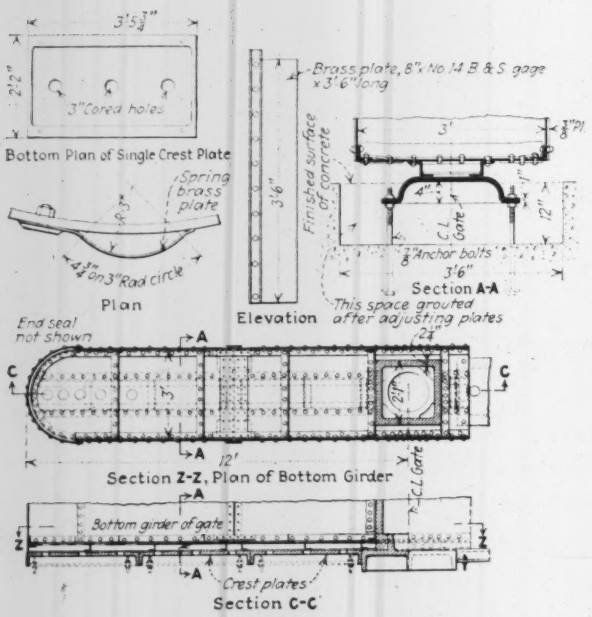
Leakage at the bottom is prevented by the close contact between the cast-iron gate and parallel webs projecting from the bottom of the gate. A close fit between these rubbing surfaces was secured by screw adjustments of the bedplates against the gate webs after the gates were adjusted in place and before the sills were grouted.

In assembling the gates the pivot plate under the central shaft was first set in concrete, the gate was placed upon it and leveled up and the concrete was poured around the I-beams. The crest plates were then brought up tight against the bottom of the gate by means of the nuts on the anchor bolts. Finally the gate was opened and the crest plates were grouted in place.

The gates are operated by a 20-hp. motor mounted on a car which moves along a standard-gage track on top of the dam so as to operate any of the seven gates in the set, one at a time. Two of these cars are provided, one for the north and one for the south spillway, each operating on a track 175 ft. long.

The operating gear is of the rack and pinion type, the pinion being fastened rigidly to the top of the gate and the rack being driven by a pair of screws and nuts operated through a set of reducing worm and bevel gears by the motor car. The 900-r.p.m. motor is connected through a flexible coupling to a 20 to 1 speed reducer which operates the spur gear. The speed reduction is such that with the motor running at 900 r.p.m. the butterfly gate makes one-quarter turn, or from open to closed position, in 18 minutes.

Connection between the motor car and the mechanism on each gate is effected by simply meshing the spur gear on the motor car with the similar gear which drives the gate-swinging mechanism. These gears are



SPRING-BRASS END PLATE, PLAN AND ELEVATION DETAILS OF BOTTOM GIRDER AND CREST PLATES

in mesh when one shaft is directly above the other with the motor car in its normal position on the track. When the gears are meshed, the car is clamped to the rails by grab hooks controlled by a hand wheel and is thus held firmly at its proper level.

The motor is operated by an ordinary controller and a limit switch cuts off the current just before the gate reaches extreme position. In order to complete tight closure of the gate it is then necessary for the operator simultaneously to press a reset button and to hold it down while operating the controller lever. The lever and button are relatively so placed that both hands must be employed to use them simultaneously. This feature was provided as a safeguard to prevent a negligent operator from jamming the gates by leaving the controller while the motor was running.

The design of these gates was developed by A. J. Wiley, consulting engineer on this project. M. H. Slocum is superintendent for Bent Bros., the contractors. For the information contained in the foregoing, *Engineering News-Record* is indebted to Daniel McFarland, assistant engineer, Merced Irrigation District.

Highway Bridges To Connect New Jersey and Staten Island

Details of Two Large Structures Being Built by the Port of New York Authority Across Arthur Kill

By O. H. Ammann
Bridge Engineer, Port of New York Authority, New York City

TWO large highway bridges are now being built across Arthur Kill, one at Perth Amboy and one at Elizabeth by the Port of New York Authority. They were authorized in 1924 by legislative acts in New York and New Jersey and by Congress, and an amount of $200,000 was appropriated by the two states for the preliminary work for the two bridges.

Funds became available July 1, 1924, and in February, 1925, a report on the preliminary work, embracing traffic studies, surveys, borings, and preliminary designs and estimates of cost, was submitted to the governors of the two states, and thereupon the legislatures passed laws appropriating $4,000,000 towards construction. Approval by the War Department was obtained in November, 1925, and in March, 1926, Port Authority bonds, to the amount of $14,000,000, were sold and thereupon steps were taken to prepare and organize the work for construction.

Contracts have been awarded for the substructure of both bridges, and it is expected that construction work will be started next month and that both bridges will be completed, ready for traffic, the latter part of 1928.

Both bridges have been finally planned to accommodate highway traffic only, each carrying, on a single deck, a four-lane vehicular roadway and two 5-ft. sidewalks. The roadways will have a bitulithic paving on a reinforced-concrete slab. The curbs and the footwalk slabs are to be made of reinforced concrete. The maximum roadway grade is 4 per cent.

Plazas of ample size, with toll booths, are provided for at each end. Suitable architectural treatment will be given to the entrances.

Provision for rapid transit passenger traffic for the Perth Amboy site was given careful consideration, but it was found that the prospective volume of traffic and the cost involved did not warrant such provision.

The Outerbridge Crossing—The bridge at the southwestern end of Staten Island is known as the Outerbridge Crossing. It extends from Francis St. in Perth Amboy to about 1,400 ft. east of Arthur Kill Road in Tottenville, a total length of about 10,200 ft. Arthur Kill is crossed by a high-level cantilever bridge 1,500 ft. long with a central span of 750 ft. and a clear height above water of 135 ft. The cantilever is flanked by two 300-ft. through truss spans. The main members of the trusses are to be of structural silicon steel. All other parts are to be of ordinary carbon steel. The steel trusses of the main river bridge are to be supported by arched concrete piers and the pier bases are to rest on timber piles.

The approaches will consist of plate-girder spans supported by arched concrete piers, resting partly on timber piles, partly on reinforced-concrete piles, and partly on spread footings. The river bottom consists of silt to a depth of about 50 ft. for the full width of the Arthur Kill and extending several hundred feet under the Perth Amboy approach, but gradually de-

creasing in depth. The rest of the approaches will rest largely on firm s il close to the surface.

The cost of this bridge is estimated at approximately $10,000,000.

The Elizabeth-Howland Hook Bridge—The other bridge extends from Edith Ave. in Elizabeth to McKinley Ave. in Howland Hook, a total length of about 8,600 ft. The Arthur Kill crossing is a high level cantilever truss bridge 1,152 ft. long, with a center span of 672 ft. and a clear height of 135 ft. The approaches consist of plate-girder spans. All spans are supported by arched concrete piers of design similar to those of the Outerbridge Crossing. The borings indicate that bedrock is fairly close to the surface, and it is expected that all the piers of the main river bridge will be carried thereto.

The piers of the Elizabeth approach will likewise be carried down to rock. In the Howland Hook approach the piers are to be supported by timber piles.

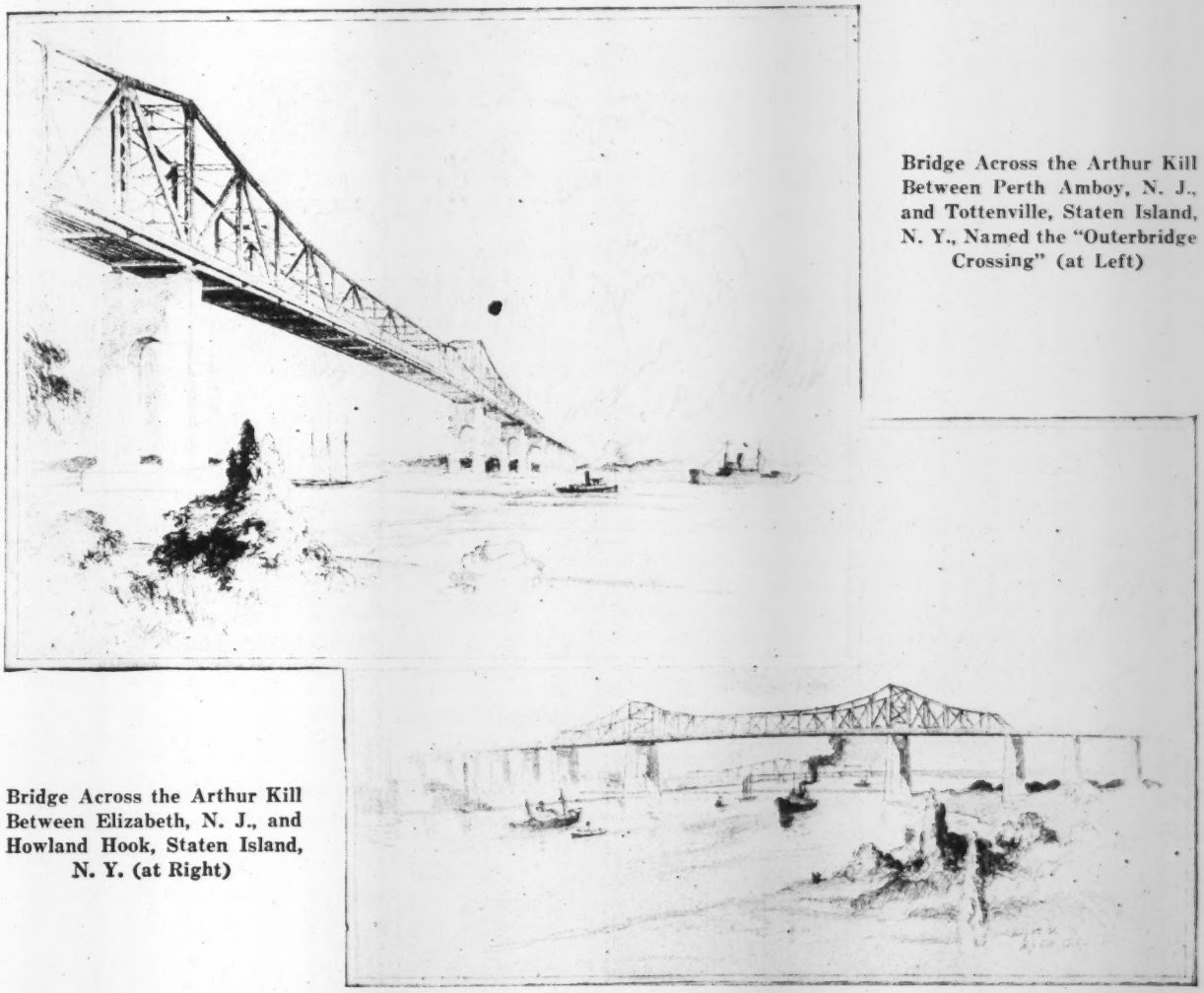
The cost of this bridge is estimated at approximately $7,000,000.

Personnel—The construction of the two bridges is under the direction of the Staff of the Port Authority. J. E. Ramsey, chief executive officer, is in general administrative charge. O. H. Ammann, bridge engineer, is in general charge of the engineering work and W. J. Boucher is in charge of construction. Prof. William H. Burr, Gen. George W. Goethals and Dr. J. A. L. Waddell act as consulting engineers, and York & Sawyer as architects.

The designs and specifications for both bridges have been prepared by Dr. J. A. L. Waddell, with Shortridge Hardesty, associate engineer, in general charge thereof.

The contracts for the substructures have been awarded to the following concerns: Perth Amboy approach to Outerbridge Crossing to the P. J. Carlin Construction Co., the Tottenville approach and river piers of the Outerbridge Crossing and the Howland Hook approach of the Elizabeth crossing to the Frederick Snare Corp., and the Elizabeth approach to Triest Construction Corp.

The accompanying views of the two bridges as they will look when completed are from pencil sketches prepared by the Port Authority.



Bridge Across the Arthur Kill Between Perth Amboy, N. J., and Tottenville, Staten Island, N. Y., Named the "Outerbridge Crossing" (at Left)

Bridge Across the Arthur Kill Between Elizabeth, N. J., and Howland Hook, Staten Island, N. Y. (at Right)

Quebec Province Busy with Road Work

Over $6,000,000 is being spent on road work this summer by the Highway Department of the Province of Quebec, to maintain and improve local roads and to complete some of the main highways. In the course of the current year sixty new bridges will also be built, under supervision of the Department of Public Works.

From Job and Office

HINTS THAT CUT COST AND TIME FOR THE CONTRACTOR AND ENGINEER

Finishing Widened Highway Curves By Machine

HOW to use a finishing machine on super-elevated and widened curves, has always been a problem particularly where the crown of the road was flattened on the curve. The method generally used in the past

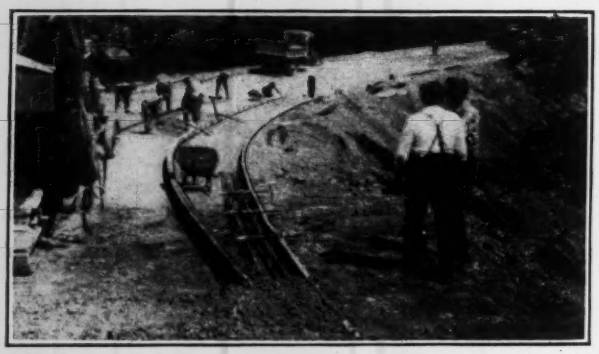


FIG. 1—FALSE FORM FOR CARRYING FINISHING MACHINE AROUND WIDENED CURVES

has been to finish around the curve for the width of the machine (which was carried on a false form, Fig. 1), and then complete the widened portion by hand. Operations of this character have been described in *Engineering News-Record*, March 26, 1925, p. 532, and April 8, 1926, p. 580. Besides the considerable hand finishing required by this method for that portion of the slab

FIG. 2—EXTENSION SCREED FOR FINISHING FULL WIDTH OF WIDENED CURVE

not spanned by the machine, a further complication was added where the crown was changed from normal on tangent to nothing on curves.

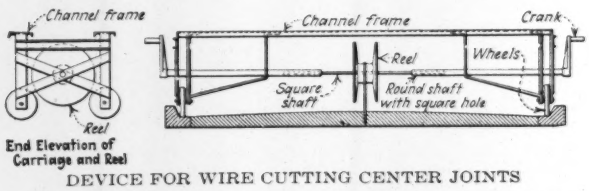
To overcome these difficulties, and obtain the same results from the finisher on widened curves as on straight sections, McPherson Brothers, contractors, Edgeworth, Pa., with the co-operation of the Pittsburgh District office of the Lakewood Engineering Co., developed a new method which has made it easy to obtain a flat crown, and to finish the entire width of the slab on a curve at one operation with the machine. Briefly, the method utilizes an extra screed member for the finisher, long enough to span the slab at the widest portion of the curve. To carry the machine around the curve, a false form was set (Fig. 1). This consisted of two 2x8-in. timbers spiked together. Concrete was deposited for the full width of the slab. Then the regular screed member of standard width and crown was removed from the machine, and replaced with a special screed member 6 ft. longer than the regular screed. This extra member could be attached so as to put the additional length on either side of the machine, to take care of reverse curves. Furthermore, the extra screed board was set for flat crown. It is shown in operation by Fig. 2. The time required to change from the standard width to the extra width screed member, was less than a half hour.

The particular job on which this method originated was located in Allegheny county, near Pittsburgh, Pa. A number of grades were encountered, some of which were as much as 10 per cent. In places the road was a succession of widened, super-elevated curves, with flat crowns. In addition, slag concrete was being used, and often the slump was as little as ½ in.

Wire Cutting Center Joints in Concrete Paving

BY C. C. HERMANN
Aero-Mail Engineering Service, Moline, Ill.

SOME difficulty has been experienced by contractors in producing longitudinal center joints in concrete pavements. Center plates are more or less unsatisfactory. Unless some special protection is provided on the skip, it drives the plate into the subgrade. Use of short metal strips just behind the mixer may result in a crooked joint. Having these things in mind, the writer has devised a means of wire cutting the longitudinal joint.



DEVICE FOR WIRE CUTTING CENTER JOINTS

This method involves the placing of a 10-gage plain annealed wire in the center of the paving directly on the subgrade. Several hundred feet of wire may thus be placed ahead of the mixer. A reel mounted on a shaft having rollers matching with the curb rails is placed on the pavement following the mixer. When the concrete has set to a certain extent the wire is drawn by turning the reel. The reel is secured to the shaft and the shaft is rotated by a crank from the curb end.

Although it is true that in the event a large stone lay over the wire it might be pulled to the surface, the actual roughing up of the joint is not much more than that following withdrawal of metal plates. The edge of the cut is readily freed of any small roughness and in case a stone is upturned the hole is easily grouted.

Welded Pipe Line for Mixer Water on California Road Work

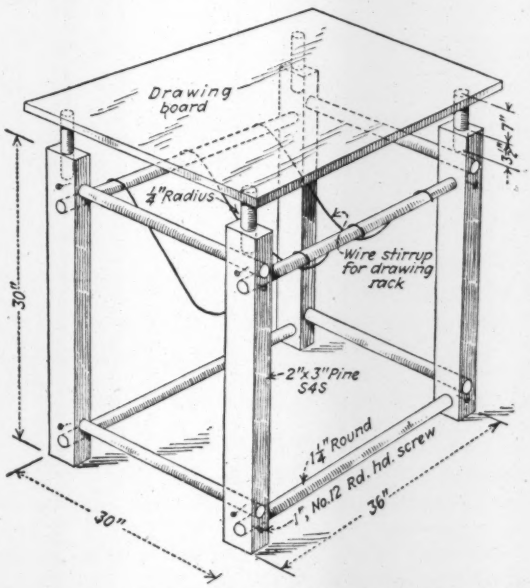
WELDED pipe has been successfully substituted for the ordinary screw-joint pipe on the Jahn & Bressi contract for concrete paving north of San Juan Capistrano, Calif., under the supervision of C. N. Ainely, resident engineer, state highway department. Jahn & Bressi contracted with the pipe company for the complete handling of the pipe during the period of construction. The pipe used, second-hand boiler tubing, is strung out over portions of the job where it is to be needed and is then welded by means of an acetylene torch. The cost of installing, which includes welding joints and pipe stubs for hydrants at 100-ft. intervals, was reported to have been 3½c. per foot for 3-in. pipe and 5c. per foot for 4-in. pipe. With the pipes laid end to end as unloaded from the truck, one man can average 35 welded joints per day. The time of welding in a stub for a hydrant is about 10 minutes.

The use of welded pipe has a number of advantages. The line can be shifted without danger of breaking, if ordinary care is used; a leak or break is easily repaired and the line is readily disconnected with the torch for moving. The boiler tubing with the welded joints used on this job will stand about 500 lb. pressure. It is asserted that there is no noticeable increase in friction head due to the use of this pipe; in fact, friction is decreased. Welded pipe has been used on two jobs with success, which, apparently, establishes the fact that it is cheaper than other pipe.

Demountable Drafting Table

By John R. Jahn
Consulting Engineer, San Francisco, Calif.

THE writer has found the drafting table support illustrated herewith to be very convenient for both field and office use. It accommodates a 30x36-in. drawing board which rests on the removable pegs when used standing, and on the 2x3's when used seated.



DETAILS OF INEXPENSIVE PORTABLE DRAFTING TABLE AND SUPPORT

The rungs are 1¼-in. round and fit into holes through the uprights in which they are held by the 1-in. No. 12 round-headed wood screws. By loosening these screws the rungs may be slipped out and the whole frame "knocked down" into a compact bundle for travel. It is remarkably rigid. Drawings can be rolled up and laid across the rungs or wire stirrups.

The lumber in the drafting table cost $2.25 and the planing mill charged $1.25 for sawing and boring.

Wind-Blown Sand Slopes Stabilized by Light Asphaltic Oils

DRIFTING sand is to be kept off the new concrete road through the sand hills section of the Imperial Valley in California by oiling the shoulders and slopes. To determine the best oils tests were made and are reported by C. L. McKesson, materials and research engineer as in the accompanying tabulation.

In making the tests various oils were used with asphalt contents up to about 65 per cent. The experiments have demonstrated that the oil best suited for the work should contain 40 to 50 per cent of asphalt. Oil of this kind can be applied without heating and will penetrate readily. There is a sufficient asphalt content to give good body and to hold sand particles together in a heavy flexible mat after the more volatile oils have evaporated.

TABLE—RESULTS OF TESTS OF PENETRATION OF DESERT SAND WITH VARIOUS ASPHALTIC OILS

Kind of Oil	Sp. Gr. Be. Deg.	Amt. per sq. yd. Gal.	Penetration Cold Sand	Penetration 150° F. 1 Week	Remarks
43 per cent asphalt	18.2	½ ¾ 1	½ ¾ 1	1¼ 1½	Applied at about 75° F.
Fuel oil	17.2	½ ¾ 1	½ ¾ 1	¾ 1¼	Applied at about 75° F.
50 per cent asphalt road oil	16.8	½ ¾ 1	½ ¾ 1¼	½ 1¼ 1½	Applied at about 75° F.
62 per cent asphalt road oil	15.2	½ ¾ 1	¼ ½ ¾	¾ ¾ 1¼	Applied 150°-175° F.
65 per cent asphalt road oil	13.7	½ ¾ 1	¾ ¾ 1	1 1¼	Applied 150°-175° F.

A Diesel oil was also tested but it lacked "body" and did not produce a good oil mat on the sand.

The sand was placed in pans having an area of 1 sq.ft. and the oil applied in a finely divided spray under an air pressure of 50 lb. Repeated trials indicated that ½ gal. per square yard was the least amount that would entirely cover the sand. The lighter oils were applied cold and the heavier oils were heated. After the application of oil, the resulting oil cake was cut in small squares and the average thickness measured. The values given in the table are the average of a number of samples.

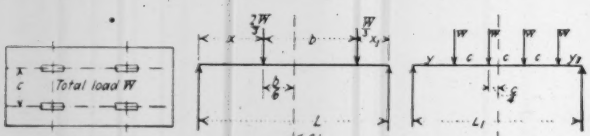
After measuring the penetration of oil in the cold sand the pans containing the sand were placed in an oven and maintained at a temperature of 150 deg. F. for one week and the depth of penetration again determined. This was done to determine maximum probable penetration which will be obtained in the summer time under desert heat conditions. All of the oils gave good penetration without heating and were therefore recommended for use.

Equivalent Uniform Loads for Truck Concentrations

By M. Hirschthal
Concrete Engineer, Lackawanna R.R., Hoboken, N. J.

THE question of distribution of concentrated loads on reinforced-concrete slabs has had as many solutions as there have been designers, each with fairly good support for his contentions. W. A. Slater's tests leave no doubt that the effect of concentrated load is diffused over a wide area. Various state highway departments have adopted arbitrary distributions for the live-load concentrations of truck and roller loads.

In the design of overhead highway bridges along the Lackawanna R.R., the writer has found it desirable to use the two-way square (or nearly square) slab and girder type of bridge where at all possible, and had to decide on the distribution of the live-load concentrations on such slabs. Some years ago he developed the following rational method of distribution, which has since been followed in all bridges of this type of design.



FIGS. 1-3—TRUCK DIAGRAM; AND LONGITUDINAL AND TRANSVERSE DISTRIBUTION

While most of the designs are for a 20-ton truck with two-thirds of the load on the rear axle, there are other truck loadings, so that it seemed necessary to develop a general method rather than a single rule.

Using the truck data given in Fig. 1, and the slab span lengths L longitudinally and L_1 transversely, the equivalent uniform load for longitudinal distribution, w per lineal foot, is first found, and from this the final equivalent uniform live-load, w_1 per square foot, is found by considering the transverse distribution.

Longitudinal Distribution—The truck being located in position for maximum longitudinal moment (Fig. 2), the moment for one set of wheels is computed as

$$M = \frac{\frac{2}{3}\,\frac{1}{2}\,W x_1 + \frac{1}{2}\,\frac{2}{3}\,W(L-x)}{L}\,x$$

But for the maximum-moment position, $x = \frac{1}{2}L - \frac{1}{6}b$, and $x_1 = \frac{1}{2}L - \frac{5}{6}b$. Inserting these values and reducing,

$$M = \frac{W}{6L}\left(\tfrac{2}{3}L - \tfrac{1}{2}b\right)\left(\tfrac{1}{2}L - \tfrac{1}{6}b\right)$$

$$= \frac{W}{24L}\left(3L^2 - 2bL + \tfrac{1}{3}b^2\right)$$

To obtain the equivalent uniform load longitudinally, this moment is equated to $\frac{1}{8}wL^2$, which gives the result,

$$w = \frac{W}{3L^2}\left(3L^2 - 2bL + \tfrac{1}{3}b^2\right)$$

Transverse Distribution—Two trucks are placed at a distance apart equal to the transverse wheel base, going in the same direction, but so located as to give the maximum transverse moment (Fig. 3). Considering a 1-ft. strip extending across the bridge, this strip of the floor is loaded at each set of wheels by the load w just found. Then the maximum transverse moment in the strip is,

From Job and Office

HINTS THAT CUT COST AND TIME

$$M_1 = \frac{w}{L_1}\,(4y_1 + 6c)(c + y) - wc$$

But for the position of maximum moment $y = \frac{1}{2}L_1 - \frac{3}{4}c$, and $y_1 = \frac{1}{2}L_1 - \frac{7}{4}c$. Inserting these values and reducing

$$M_1 = \frac{w}{L_1}\,\left(L_1^2 - 2cL_1 + \tfrac{1}{4}c^2\right)$$

Equating this to the moment of the equivalent uniform load, $\frac{1}{8}w_1L_1^2$, we find this equivalent load to be,

$$w_1 = \frac{8w}{L_1^2}\,\left(L_1^2 - 2cL_1 + \tfrac{1}{4}c^2\right)$$

Substituting the value of w already found, we have

$$w_1 = \frac{8W}{3L^2L_1^2}\left(3L^2 - 2bL + \frac{b^2}{3}\right)\left(L_1^2 - 2cL_1 + \tfrac{1}{4}c^2\right)$$

While this formula appears complicated and cumbersome, it presents no real difficulties. However, it might be simpler first to calculate w, then substitute its numerical value in the equation for w_1, and thus obtain the final result in two operations rather than by substitution in the one equation.

Example—Let it be assumed that the load to be carried is a 20-ton truck with wheelbase 12 ft. by 6 ft., and that the panels are 30 ft. longitudinally and 28 ft. transversely. By substituting in the final equation we have

$$w_1 = \frac{8 \times 40{,}000}{3 \times 30^2 \times 28^2}\,(3 \times 30^2 - 2 \times 12 \times 30 + \tfrac{1}{3}\,12^2)\,(28^2 - 2 \times 6 \times 28 + \tfrac{1}{4}\,6^2)$$

$$= 166 \text{ lb. per sq.ft.}$$

which is the design live-load for the panel. This when added to the assumed dead-load is distributed in the two directions in inverse proportion to the fourth powers of the spans.

While the method and formula apply to two-way reinforced slabs, the method may be applied to one-way reinforcement with sufficient reinforcement in the direction normal to the span for any width desired for distribution.

Angle and Bearing Calculations Checked by Simple and Quick Means

By F. E. Harley
Resident Engineer, New Jersey State Highway Commission, Paterson, N. J.

TO simplify the checking of calculations of bearings and angles on survey work, the circular slide rule shown herewith was devised. It consists of two graduated discs; "A", the inner scale, is graduated from 0 deg. to 180 deg. left and right and "B" is graduated in bearings. Then there are the movable pointer "C" and a fixed pointer "D".

In the equation:

Bearing D+Angle DEC=Bearing C,

either a bearing or the angle unknown may be solved with one setting.

As an example, the reading as shown in the sketch is:

N 80°W+140°=N 60° E. (1)

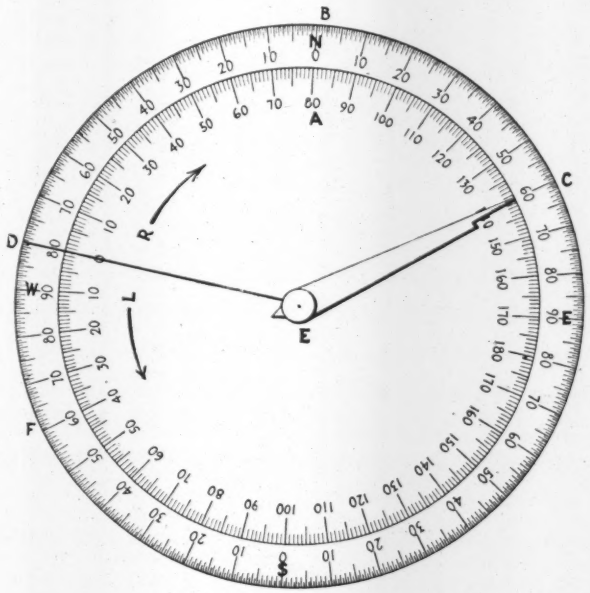
or if pointer C is at F

From Job and Office

FOR CONTRACTOR AND ENGINEER

N 80°W+S 60°W=40° (2)

In the ordinary method of calculation, rules for adding and subtracting from 180 deg., or the sum or difference of the bearings must be remembered to solve the above



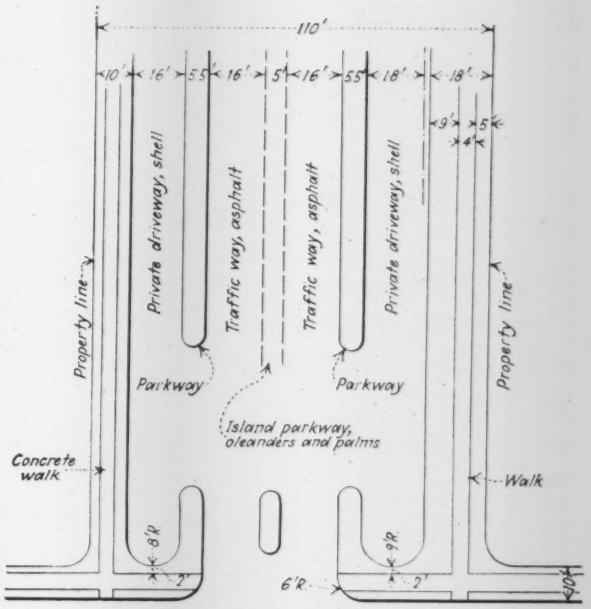
ROTRACTOR FOR CHECKING ANGULAR CALCULATIONS

equation, while by the use of this slide rule, the equation may be solved with one setting. For bearings and angles in degrees and minutes, it gives an approximate check of the accuracy of the work, though the exact angles and bearings must be calculated, as the scales read to degrees only.

Protected Parking Space on Wide Street with Double Traffic Way

IN THE Del Mar real estate addition to Corpus Christi, Tex., wide boulevards are provided with double traffic ways and private driveways thus protecting the automobile parking space from the fluid traffic by 5½-ft. parkways. Entrance to the car parking space is near the end of the blocks. Pedestrians are served by carrying the walks over the private driveways to the curb of the fluid traffic ways thus eliminating one of the objections to wide streets. Since the traffic in the private driveways will be small and necessarily of slow speed, shell was used as the paving material, while the central main traffic lanes are of asphalt. Due to an unequal dedication for street purposes the particular street shown has a wider parkway and parking space on one side than on the other.

The idea was suggested by F. R. Allison, one of a firm of real estate operators subdividing a 200-acre tract on which $500,000 is being spent for complete improvements of paving, curbs and walks, sewers, water, gas,

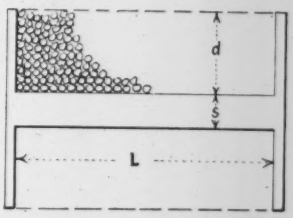


BOULEVARD LAYOUT WITH PRIVATE DRIVEWAYS FOR PARKING SPACE PROTECTED FROM TRAFFIC WAY

seeding and planting. The engineering details were worked out by H. Levinson, city engineer, who has also supervised the construction.

Job and Office Notes

How Many Feet On a Reel? Inasmuch as reels are commonly used for storing rope, cables, wire, hose, etc., and inasmuch as I have never seen a satisfactory formula for computing the length of these stored or wound up articles I devised a formula. When a rope, cable, or wire winds upon a shaft or reel it assumes a position such as I have endeavored to indicate in the sketch herewith. That is, the rope when winding onto the first layer seeks the "valleys" between the turns of the first layer. In this way the maximum length of rope is wound onto the reel. This is particularly true if the rope is taut. To determine the number of feet on a reel four measurements are necessary, three of which are indicated on the sketch herewith and the fourth is the diameter of the rope, wire, or cable, in inches. The rule is as follows: To the depth of the rope or cable d, add s, the diameter of the shaft, multiply by the depth d, multiply by the inside length of the reel, L, and divide by the square of the diameter of the rope or cable. Finally, multiply by 0.3. The answer will be the length in feet.—W. F. SCHAPHORST, Newark, N. J.



Measuring Reinforcing Bar Sections For Test—Reinforcing bar cross-sections, it has been found by the United States Bureau of Public Roads, do not always check in actual measurement with the area given in the manufacturers' tables. D. O. Woolf, Junior Materials Engineer, reports, in *Public Roads* for July, 1926, a method for actual measurement. The test specimen is cut through at right angles to its axis, and the cut surface is filed smooth. An impression of this surface is made by the use of carbon paper or stamp pad and the area measured by polar planimeter. Variation in section as high as 45 per cent has been noted by this method.

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

Embrittlement of Steel and Copper

Sir—The article on embrittlement of metals in your issue of July 22, p. 151, recalls to mind two similar instances of embrittlement which could scarcely have been caused by chemicals.

In a large hydro-electric development in the South with which the writer was connected fourteen years ago some turbines were installed which had blades made of soft boiler steel about ½ in. thick. After a few months' service some of these blades broke off. In most cases the fractures were coarsely crystalline, with little or no bending or distortion. Tests along the line of fracture showed the metal to be still soft and ductile in spite of the crystalline fracture. There were several such breaks at different times.

Just recently the writer saw a piece of copper wire, about ¾ in. thick, which had been immersed in a flush tank for three or four years. At the time of installation the wire must have been as ductile as copper wire usually is, for it had been twisted and bent around a bar. At the time of failure the wire was as brittle as glass, had a very coarsely granular structure and at its center was the color of brass, as though segregation had taken place.

I would like to hear from some metallurgist, as to the possible causes of such a change in structure.

New York, July 27, 1926. FRANK C. BOES, Tucker Construction Co.

Crest Gates on Dams

Sir—*Engineering News-Record* of March 25, 1926, p. 499, prints a formula and diagram for weight of crest and head gates for dams and canals. Its author notes a doubt as to whether accessories are included. There are other and graver sources of uncertainty—one due to dimensions not being correctly stated for the purpose of the study. The unit weight of gates depends on the width between centers of bearings whereas the hydraulic dimension which is the clear width is that usually stated. The relation between these is by no means constant.

Another—the pressure against the gate in terms of head—should and perhaps usually does include a surcharge or allowance for water flowing, or backing up, over the gates. Of course this is supposed not to occur, but there are probably very few gates which do not at times have such a spill over them. Most of the gates the writer has had to do with, several hundred at least, have been designed for several feet surcharge under extreme conditions. This applies to crest and head gates; not so much to sluice gates.

The data quoted on p. 499, most of which are also given in reports of the N.E.L.A., are in several cases subject to the uncertainties above noted. The writer has exact data on a number of these and on many gates not therein included. He has been greatly interested in comparing all the available data to find much closer agreement than he expected. He prefers to analyze the data and formula on a semi-rational basis as follows:

Either crest or sluice gates of considerable size whether of the Tainter (radial) or Stoney (sliding) type are structurally analogous to bridges, in that they transfer loads across spaces where support is lacking, concentrating them at points where adequate support can be provided. The weight of structure will be a function of load and span. We may eliminate two of the variables, the overall dimensions, and find an expression for weight per square foot in terms of H = average head (vertical distance of center of gate below water surface), and W = width c. to c. of supports. The data available, twenty-one independent designs for each, reduced by a method approximating least squares give:

For Tainter gates, lb. per sq.ft. = $0.185\ H^{av.}\ W$. clear

For Stoney gates, lb. per sq.ft. = $0.190\ H^{av.}\ W$. c. to c.

These formulas give results well within the variation due to personal equation and mill allowance, and include a reasonable allowance for seat facing and hinges. Seat facing is so much a matter of personal prejudice that no formula can give even approximately correct figures for direct use. Included in the gate weight it is of course averaged. Sluice gates if not encumbered with too many special conditions will vary little from the above formula, though the amount of data available is not sufficient to make the coefficient dependable. The coefficient is probably too small for high heads. There are also indications that weight per square foot increases less rapidly than first power of head.

It is perhaps hardly necessary to call attention to the limits of all such formulas. The above apply to widths up to about 60 ft. and heads to 30 ft. or less with a unit stress 16,000 lb.

It is further noted that the diagram in *Engineering News-Record* of March 25 appears not to agree with the formula. The constant 34 seems to be plotted 14 (but correction was noted April 22, p. 661—EDITOR).

For small gates the two formulas agree fairly well. For large gates the one here given is to be preferred as it is based on a greater range of data. H. K. HIGGINS, Assistant Engineer, Alabama Power Co.

Birmingham, Ala., August 10, 1926.

Too Complete Specifications

Sir—The following is an exact copy of a specification for a public building upon which we have been asked to submit a competitive bid.

"The contractor shall submit to the architect a complete detail section with dimensions and size of all important features noted thereon, fully descriptive in every particular, of the system of reinforcement proposed. This shall also include the static computations, designating the loads assumed separately, such as dead, live, wind and impact, together with resulting stresses.

"The approval of plans by architect shall not relieve the contractor of the responsiblity of the sufficiency of his work.

"Methods of Construction:

"Before proceeding with the work, or any part thereof, the contractor shall submit to the architect proposed outline of the method of construction, accompanied by such plans as may be necessary to fully illustrate it. These shall be open to such suggestion and comment as in the opinion of the architect are deemed necessary in the interest of the work, and in the event of the proposed outline or any feature thereof being inimical to the interests of the owners of the structure or evidently insufficient to accomplish the results intended, may be disapproved, whereupon a different method and plans shall be submitted by the contractor. In any event, the contractor shall be held entirely responsible for the sufficiency of the proposed method of construction."

We as contractors are willing to go the limit in assisting the architectural profession, but is it fair to ask a contractor to figure competitively on such a basis?

Lansing, Mich. Aug. 10, 1926. H. L. CONRAD, Chief Engineer, H. G. Christman Co.

A Convert to Municipal Civil Service

Sir—I appreciate your editorial note, "A Civil Service Question," in the issue of Aug. 5, 1926, p. 204, and I believe, in the interest of all concerned, that I should give you the results of my experience with civil service.

Until about four years ago I was as prejudiced against civil service as anyone could possibly be. I came into an office of some two hundred or more employees who were under civil service and for a period of four years I have watched very carefully the working out of the civil service idea.

In the city of Seattle, the Civil Service Commission is composed of three members appointed by the mayor and confirmed by the city council. The members of the commission receive small compensation and meet usually once a week. The active work of the commission, however, is done by the executive secretary and his corps of examiners. These examiners are well educated and qualified engineers, all of whom I believe have degrees from colleges of recognized standing. They have taken up very actively the study of the qualifications for technical work, as well as the human element. I believe that their experience in selecting and grading the number of employees who qualify for city work renders them more capable of selecting proper

material than any one individual could possibly be, particularly where the individual's time and attention were distracted by a diversity of matters.

When it is necessary to appoint a man to a position in any office, the head of a department submits to the Civil Service Commission the specifications for the kind of man he wants, setting forth what he is to do, etc., and from the qualified lists of prospective employees the commission selects three names—called "certifying candidates." From these three names the department is permitted to select the one it prefers. The person chosen is given a 6 months' trial, and during or at the expiration of this time, if the man fails to make a minimum rating, he is automatically discharged and the department has the privilege of selecting one of three on a new certification, and this process is continued until a satisfactory man is found.

As it has worked here, we have found no difficulty whatever in eliminating any employees that were not satisfactory, and the secretary and examiners particularly have sought to co-operate with us in every way possible to get the best results. The character of the men that we have had to deal with so far has been above the average of the various private engineering offices—railroad and otherwise—that I have worked in throughout the country, and I am perfectly willing to pit my force, man for man, in point of accomplishment with that of any private office.

I have reached the conclusion that the attitude I formerly held, and the one so many seem to hold at the present time, is based on a misunderstanding of the advanced methods of handling men. Bloomfield in his "The Modern Executive" makes the statement: "The modern management has learned from solid experience to make a distinction between the leader of men and the driver of men." A man can be brought to accomplish much more by appealing to his human side and getting his interest than from the fear motive. I will admit that it appeals to a man's vanity to feel that he is a czar and that his word may go unchallenged, but the average engineering employee, particularly if he has been selected as ours are selected, possesses qualifications, barring experience, oftentimes equal to or superior to your own. In city work, where there is a tendency for politics to play its part, and where men who are liked by the appointing powers sometimes get preferment not justified by merit and in case of lay-off men are selected by preferment rather than merit, civil service fills a long-felt need and prevents injustice being done.

For these reasons, I believe that the civil service has come to stay and, if properly carried on, assures an employee that if he attends to business and gets results, he need not spend his spare time in playing politics.

I would further state that many men who are ranting so against the inefficiency of men in civil service really do not know either what their own men or the civil service people are accomplishing. Recently the statement was made by the head of one of the manufacturing plants that his men were accomplishing approximately 25 per cent more than the men under the civil service. I challenged the statement, and so far as I was able to find out, there was no possible way he could tell what his men were doing, except in the most general way.

J. D. BLACKWELL,
Seattle, Wash., City Engineer.
Aug. 16, 1926.

Nitrification in Sewage Filter Beds

Sir—In my discussion (*Engineering News-Record*, June 24, p. 1035) of Mr. Cohn's experiments on sewage chlorination I tried to explain that the nitrifying organisms did not "adjust" themselves to the chlorine as Mr. Cohn presumed, but that the chlorine was more or less absorbed by the colloidal matter. In connection with this explanation I quoted our results saying that nitrification takes place mostly in the bottom of the beds. Mr. Clark, in your issue of July 8, p. 74, states that our findings are "directly contrary to the Lawrence Station results" which "show that nitrification begins near the surface and increases progressively and proportionally to the depth of the filter.

The purpose of a filter bed is oxidation of suspended and soluble material. The *soluble* material might begin to oxidize at the top of the bed, however the freshly deposited organic colloidal material from the tank is not ready for the nitrification processes. This colloidal material, carrying large numbers of putrefactive organisms, begins to decompose (reduction) accompanied by odors. The rate of reduction of this organic matter increases and gradually overbalances the rate of oxidation. As soon as the colloidal material retained by the top layer is partly decomposed, the decomposition products are washed down by the successive sprays and oxidation sets in. At Plainfield the rate of reduction of organic material is about equal to the rate of oxidation at the 3-ft. level. At the 5-ft. level, the rate of oxidation overbalances the rate of reduction (numbers of nitrifying and reducing organisms bear this out also). The suspended solids thrown on the bed are fairly uniform throughout the year. With an average of 75 p.p.m. suspended solids thrown on the bed (Plainfield joint works) oxidation takes place mostly at the bottom and from 1 to 3 ft. of the bed is required for the reduction processes. Changing the load to be carried by the bed, the region of most efficient nitrification will be changed. If only a part of the colloidal material thrown on the bed at Plainfield is encountered the effective region will move upward and all the bed farther below is practically wasted. This means that the region of greatest oxidation in the beds will depend upon the amount of solids which can be handled and that the depth of a filter bed should be designed in accordance with the solids concentration. It is therefore quite possible that the region of greatest nitrification is nearer to the top at the Lawrence Station, without being contrary to our findings.

W. RUDOLFS.
New Brunswick, N. J., Chief Sewage Investigations,
Aug. 14, 1926. Agricultural Experiment Station.

Zoning Through the Building Code

Sir—The editorial note, "Zoning Aid," in your issue of July 22, p. 126, commenting on the plan of the city of Elizabeth to secure through its building code the desirable benefits sought by zoning ordinances, reinforces a conviction which I have held and advanced publicly for some time. As a principle, zoning is not new; it has been applied in one of its phases for many years in the establishment of fire limits. Within fire limits certain types of building construction are prohibited and frequently certain uses to which buildings may be put are also prohibited. The right to do this has been granted to municipalities under the police power and there does not seem to be any good reason why further restrictions cannot be made in the building code without additional statutory authority.

Under the police power, building construction may be regulated for the health, safety and general welfare of the inhabitants, and, accordingly, building codes have sections covering fire protection, light and ventilation and the storage of materials as well as provisions covering construction, strength of materials and other physical features. Surely limitation of the height of buildings can be justified under the heading of fire protection, where it is as necessary of consideration for the safety of occupants and fire extinguishment as the materials which enter into construction. The area regulations, the establishment of minimum requirements for yards, courts and open spaces, also find justification through fire protection but obviously they would be included chiefly to secure light, ventilation and proper sanitation.

The need for the limitation of the use of buildings is perhaps not so readily shown, though the same police power is relied on when regulations are made restricting the storing of oils, volatiles and explosives. In the absence of definite statutory provisions giving cities power to regulate use, the courts are apparently reluctant to uphold use restrictions without convincing proof of their need, but it is my belief that in time sufficient data will be available to support a contention that wise and carefully studied use limitations do safeguard the health and safety of a community and are in the interest of the general welfare.

Municipalities that are contemplating zoning ordinances and are perhaps, at the same time, preparing or revising their building codes might well give consideration to securing the results to be attained in one ordinance. In my opinion the ends sought by zoning ordinances and building codes are substantially the same and their embodiment in one instrument would prove a great convenience to those who must make use of the latter.

RUDOLPH P. MILLER,
New York City, Consulting Engineer.
Aug. 16, 1926.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Labor Immigration Shows Slight Increase

In Second Year Under New Quota Law Both Common and Skilled Labor Greater than Year Before

In the fiscal year ended June 30, 1926 there was a slight increase in the inflow of laborers to this country. This was the second year of the new law which restricts the immigration from any foreign country to a percentage of the population of its nationals here in 1890. This law has reduced materially the immigration totals and particularly those from eastern Europe, but British and northwestern Europe have not sent as many as their quotas allow. The figures for the fiscal year have been summarized by the National Industrial Conference Board, they are as follows:

While during 1924-25, the first year under the two per cent quota act, 15,106 more common laborers left the United States than entered, during the past fiscal year 43,543 entered and only 33,107 left, constituting a net gain of 10,436 for the year. Skilled labor came to the United States in greater numbers than the year before, our net gain in this class during the fiscal year being 47,147 as against 42,422 the year before. Farmers and farm laborers, however, came in smaller numbers, our net gain in this classification being 25,598 in 1925-26 as against 28,266 in 1924-25.

Professional people continue to come in increasing numbers. While our net gain in professional people during the fiscal year 1924-25, the first after the two per cent quota act went into effect, was 8,367, our net gain during the past fiscal year was 9,041.

Mexican Immigration Increases

Canada and Mexico continue to furnish the bulk of our immigration under the new restriction act, neither country being subject to quota restriction. Immigration from Mexico appears to be increasing, that from Canada declining, as far as the past two years' figures indicate. Canada during 1925-26 contributed in excess of 91,000 immigrants, about 9,000 less than the year before, while Mexico sent 43,316, or about 10,000 more than the year before.

The pressure on immigration quota is clearly discernible in the immigration statistics in reference to countries whose emigration to the United States was most restricted by the new law, as for instance Italy, or Greece. While Italy's quota is 3,845, actually 9,374 Italian immigrants entered the United States during the fiscal year 1925-26, the excess over the quota consisting of non-quota immigrants, such as wives and children of Italians having acquired citizenship here, returning Italian residents of the United States, world-war veterans and other Italians not chargeable to the quota.

The exodus of Italians from the United States, so marked during the previous year, when it amounted to 27,252, was still heavy during the past fiscal year, 20,004 Italians leaving the United States during the year, constituting a net loss in Italian alien population of 10,630.

The migration of Greek aliens, who are restricted to the minimum quota of 100, while much smaller in numbers, resembles that of the Italians. During the fiscal year just past, 1,385 Greek immigrants entered the United States.

Immigration from the Irish Free State, which is credited with one of the largest three quotas, appears to be fairly stationary, 27,590 entering under the quota during the fiscal year 1925-26 as against 27,125 the previous year. The quota is 28,567. A total of only 5,147 non-quota immigrants and non-immigrants entered during the year from the Free State, making the total of aliens admitted from southern Ireland 32,737 for the year. Total immigrants of the Irish race, which also includes Irish from Northern Ireland as well as Irish coming from other countries, amounted to 42,475 during the year, as against 42,661 the year before.

Engineering Fifty Years Ago

From *Engineering News*, Aug. 1876

Railway News

FORT WORTH, TEXAS, is now connected by rail with the rest of the world.

* * *

The Little Rock & Fort Smith Railway is now completed to Cherokee, on the Arkansas River, opposite Fort Smith.

* * *

Over 32,000 tons of American steel rails have been received in San Francisco from New York during the past year for the Southern Pacific Railroad.

* * *

Travelers going through to Boston by the Pennsylvania Central have their palace cars shoved aboard a steamer at Jersey City which takes them by the Battery and up East and Harlem Rivers to the New York and New Haven crossing, where they are again shoved on the track for Boston and other eastern points. The transfer occupies but little over an hour and avoids the tedious soul-stirring transfer through New York City.

Mid-Continent Engineers Meet at Duluth

International Organization Holds Its Second Annual Meeting on Missabe Range

The second International Mid-Continent Engineering Convention was held at Duluth and on the Missabe Range Aug. 12-14. The organization was formed last year to provide the engineers of the North Central States and the adjoining provinces in Canada an opportunity to get together once a year. The objects of the organization are social rather than technical, but the convention this year devoted one long session to the consideration of papers related to the production of iron ore on the Missabe Range where the latter part of the meeting was to be held. Engineers and architects from Wisconsin, Iowa, North and South Dakota, Minnesota, Saskatchewan, and Manitoba were invited by the Minnesota Federation of Architectural & Engineering Societies, the original sponsor of the convention, to attend and 370 registered at the convention.

One Technical Session

At the technical session, N. M. Hall, professor of mechanical engineering at the University of Manitoba, presented a paper on the Engineering and Architectural Organizations of Canada. A paper on the Iron Ore Situation by Walter G. Swart, consulting engineer and general manager of the Missabe Iron Co., was read by Wayne Clark in the absence of Mr. Swart. Two other papers, one by S. E. Atkins, president, S. E. Atkins Co., drill contractors, on History and Development of Diamond Drilling and a paper by William H. Hoyt, chief engineer of the Duluth & Missabe & Northern Ry. Co., on Iron Ore Transportation, were also of special interest, due to the location of the convention, and a paper by Lt. Edward G. Plank on An Application of Aerial Photograph to Map Making was illustrated by slides showing work done in the region where the convention was being held.

Speakers at the banquet held in Duluth Thursday evening were Dexter S. Kimball, president of the American Engineering Council, L. C. Moore, vice-president of the Minnesota Federation, and A. R. Leonard, of the Winnipeg Hydro-Electric Plant, as representative of the Canadian contingent.

Friday was given over to trips over the Missabe Iron Range and to the Rainy Lake Saw Mill, and Saturday was devoted to inspecting the plants of the Minnesota Steel Co., the Duluth plant of the Universal Portland Cement Co., the ore docks of the Duluth, Missabe & Northern Ry. Co., and the power plant of the Minnesota Power & Light Co. at Fond du Lac.

Decking Collapses on New York Subway Job

Warning Prevents Casualties When a 125-Ft. Length of Decking Goes Down

Weakened presumably by continued blasting in the cut for the new Eighth Ave.-Washington Heights subway, New York City, a section of the decking 125 ft. long, occupying the width of the street, collapsed Saturday afternoon, Aug. 21. It carried with it a double-track street car line with its under-deck power cables and the telephone lines were shut off, and as a precautionary measure, ambulances were summoned and all persons ordered out of the business houses on each side of the avenue. These prompt safety measures were in large manner responsible for making of the accident a structural failure rather than a disaster with considerable injury and loss of life.

The structure that failed consisted of a heavy planked roadway supported on longitudinal wood stringers. The supporting bents for this decking were made up of wooden columns and 24-in. steel I-beams. The rock cut was about 50 ft. wide practically in the center of the street. A 12x12-in. column was placed at each side of this cut while the center column consisted of two 12x12 timbers fastened together. Spanning between the columns transversely were 24-in. I's over which ran a longitudinal header beam supporting other 24-in. transverse I's directly under the deck. The top of the 50-ft. cut in rock was about 10 ft. below curb level. This top 10 ft., extending in width from the sides of the cut to the building lines was mostly earth and was held in place by sheeting and longitudinal walers braced across the trench. Short columns footing on the rock supported the decking at the sides and also the east (left hand in the illustration) sidewalk under which the excavation extended.

The rock in the cut is badly disintegrated. Immediately following the blast which preceded the sagging of the deck, one of the workmen going into the cut saw a large boulder cave from the side. The shored-up earth is then believed to have started to slide taking out the sheeting and one or more of the columns. This let the end of one of the transverse I-beams drop and its collapse probably was followed by that of the longitudinal header beam which it supported. The effect was cumulative, some dozen bents falling into the excavation. The east sidewalk carried trestle bents for the by-passed gas lines; and, as may be seen in the illustration, this sidewalk did not collapse.

There is no indication of negligence on the part of the contractors, the shoring system being practically the same as used throughout on this section of the subway. Officials of the building department who examined all adjacent buildings reported that the crash had not injured them. Rodgers & Hagerty are the contractors.

COLLAPSE OF DECKING OVER EXCAVATION FOR DOUBLE-DECK SUBWAY, NEW YORK CITY
Looking south on St. Nicholas Ave. toward 162nd St. and Amsterdam Ave.

and electric light conduits temporarily hung beneath the decking. The collapse occurred on St. Nicholas Ave. about the middle of the block between 162nd and 163rd Sts.

No one was injured since the possibility of a collapse was indicated by an appreciable sagging of the deck some 15 or 20 min. before the structure actually gave way. The sag occurred immediately following a blast when there was no one beneath the deck. Warning was immediately given, reserve police were notified, and the entire block roped off. Gas and power

Report Made on Moffat Tunnel Fatal Accident

After investigation of the fatal accident in the Moffat Tunnel on July 30, the coroner's verdict, substantiated by a finding of the State Bureau of Mines, was that this was an unavoidable accident. This cave-in, noted in *Engineering News-Record* of Aug. 5, p. 230, occurred 12,010 ft. underground, in the heading of the main or railroad tunnel, resulting in the death of six workmen who were erecting jumbo sets 150 ft. east of crosscut No. 9.

Apparently solid granite gneiss, with seams which ran the wrong direction for supporting the blocky formation, resulted in a slip which released a huge block of rock that crashed through the temporary timbering support and staging without any warning to the crew working below on the jumbo frame work. About 200 cu.yd. of rock followed from the roof and north side of the tunnel, 8 ft. above and 20 ft. beyond the last set of permanent timbering, which latter was practically uninjured by the cave-in. At the time the slip occurred, only a few feet had been opened up beyond this timbering and was being held by temporary stuls.

In catching up the ground, 12x12-in. cribbing was built up, and the cavity above the neat line of the permanent timbering was tightly packed with timber. Permanent sets of 12x18-in. Oregon fir timbers were then placed in position and the temporary cribbing was removed. Several tunnel trainloads of timber were required to support the roof during the removal of the rock and debris, and the recovery of the bodies of the workmen which were buried beneath it.

This blocky rock, which caves without warning, is said to be less difficult to catch up than the squeezing ground which occurs a few hundred feet away in the water tunnel heading, and which exerts such tremendous pressure on the timbering that it is necessary to provide against up-raising in the floor, as well as crushing from the sides. Practically the entire distance from the west portal to the west headings of the tunnel, which are over two miles in from the portal, has required lining. Surface indications gave no warning of such a condition.

On Aug. 15 the headings of the pioneer and railroad tunnels were 3,254 ft. and 4,357 ft. apart.

First Concrete Poured in Pacoima Dam

First concrete was poured in the Pacoima dam near San Fernando, Calif., Aug. 5, thus beginning the final stage in one of the important structures of the Los Angeles County flood control program. J. W. Reagan is chief engineer of the district. This dam, which will be about 385 ft. high, is a constant angle arch with a base width of 102 ft. and a crest width of 8 ft. It will contain about 180,000 cu.yd. of concrete and is to be completed in the latter part of 1927. Bent Bros. of Los Angeles are the contractors.

Wyoming State Engineer Nominated for State Governor

Frank C. Emerson, state engineer of Wyoming has received the Republican nomination for governor of the state. Mr. Emerson was appointed state engineer in 1919 and was reappointed for six years in 1921 by Governor Carey but was removed by the late Governor Ross sometime after he took office for alleged misconduct in connection with the confirmation of his appointment by the Senate. Mr. Emerson contested the removal in the courts and was reinstated by the state supreme court in January, 1924.

It is probable that the Democratic party will renominate Governor Nellie Ross, widow of the Governor who removed Mr. Emerson from office.

Vehicular Tunnel Inspected by Governors of Two States

An official inspection of the vehicular tunnels under the Hudson River at New York was made by the Governors of the States of New York and New Jersey and by the tunnel commissions of the two states on Aug. 21. Automobiles containing the inspecting party were driven through the tunnel, which is well along toward completion, most of the work remaining to be done being upon the approaches and the ventilating equipment.

Included in the inspecting party were the present engineers of the two commissions, Ole Singstad, the chief engineer, F. A. Snyder, engineer of construction, Ralph Smillie, assistant engineer of construction, and M. I. Killmer, resident engineer.

Delegates to the Road Congress at Milan Appointed

For the first time since the organization of the International Road Congresses, the United States will be represented by official delegates at the Fifth Congress to be held in Milan, Italy, beginning Sept. 6. Acceptance of membership in the Permanent Association of International Road Congresses and appropriation for the expenses of delegates to the current meeting were provided by Congress during the closing days of the last session. The following delegates have been appointed by the President: Thomas H. MacDonald, Chief of the United States Bureau of Public Roads; Paul D. Sargent, chief engineer, State Highway Commission of Maine; John N. Mackall, chairman, State Road Commission of Maryland; H. C. MacLean, commercial attaché, Department of Commerce at Rome; H. H. Kelly, assistant trade commissioner of the Department of Commerce of Paris; H. H. Rice and Pyke Johnson, of the National Automobile Chamber of Commerce.

The delegates sailed from New York City on the S.S. "President Harding," leaving Aug. 25, in order to arrive at Milan in time to take part in all the meetings of the congress, beginning there on Sept. 6 and closing at Rome on Sept. 13.

Dispute Over New Sewage-Works at Indianapolis

Disagreements and disputes between members of the Board of Sanitary Commissioners at Indianapolis, Ind., are hampering the proper operation of the new sewage disposal plant. According to press and local reports some members of the board have been trying to secure the removal of Charles H. Hurd, consulting engineer, who designed the plant and supervised its construction; and also the removal of C. K. Calvert, engineer in charge of operation. The board has proposed to engage some leading firm of engineers to review the situation, a plan to which the present engineers appear to have no objection. This plant, opened May 23, 1925, was described in *Engineering News-Record* of March 23, 1922, p. 484, and Aug. 16, 1923, p. 258. Interference by the board and its failure to provide funds for needed facilities are reported to have affected the operation of the plant, its capacity being exceeded so that at times raw sewage has to be discharged into the river. The disposal of the activated sludge is still a problem. A building was erected for de-watering and drying, but it is not yet equipped, owing to questions at issue, while funds adequate for experimental work considered advisable have not been provided. At present, disposal is accomplished by digestion in earth pits. The board is composed of three members, only one of whom is appointed by the city authorities primarily as a member of the board. Of the other two members, one is the city engineer, ex-officio, and the other is appointed by the State Board of Health. The qualifications of this last member are disputed in a suit brought to oust him from his position. An editorial in the *Indianapolis Star* says:

"The affairs of the sanitary board have reached a condition where factionalism and personal prejudice have all but eliminated the only issue of concern to the general public—the completion and efficient operation of the sewage and garbage disposal plant. So far as the former is concerned, construction has already been completed, one angle of the controversy involving nothing more than the addition of certain units to increase the plant's capacity. It is not surprising that differences of opinion might exist in consideration of the disposal problems, but the issue seems to have been subordinated in the factional wrangles which have marked the sanitary board's sessions."

Work Started on $20,000,000 Port Project at Buffalo

Work on the first unit of the $20,000,000 port development at Buffalo, N. Y., was started on Aug. 17. The first unit consists of two slips 1,100 ft. long with a pier between them. Contract for this work was let to the Monarch Engineering Co. for an amount slightly under $1,000,000. It is expected that the construction of other piers and further work in improving the outer harbor will be undertaken after the completion of the first unit.

Short-Time Rainfall Record in New York City Broken

Total of 2.46 in. Fell in 1 Hr. of which 2.34 Came in ½ Hr.—Some Brooklyn, Croton and Catskill Figures

The rainfall record for 5, 30 and 60 minutes, as observed by the New York City Weather Bureau, was broken on Aug. 12, the next highest record being July 10, 1905. The figures (inches) on the two dates, as given to this journal by James H. Scarr, meteorologist, together with some figures for the same rainfall period at Hull St., near Eastern Parkway, Brooklyn, supplied to us by Kenneth Allen, sanitary engineer, Board of Estimate, New York City, were:

	Greatest Amounts, in Minutes						Total for Storm		
	5	10	15	30	45	60			
7/10/05*.....	0.74	1.26	1.63	2.09	....	2.30	2.56	2.48 — 4.92	p.m.
7/12/26*.....	0.75	1.20	1.55	2.34	....	2.46	3.23	2.55 — 5.45	
7/12/26†.....	....	0.45	....	1.47	1.66	....	....	....	....

* Battery. † Hull St.

For Brooklyn, the maximum hourly rates were: For 5 min., 4.56 in.; 10 min., 4.32; 30 min., 2.86; 45 min., 2.27; 55 min., 1.88; 120 min., 0.88 in.

W. W. Brush, deputy chief engineer, Department of Water Supply, New York City, reports rainfall figures at three stations at considerable distances from those already named as follows: Kensico station, 0.63; Croton Lake station, 1.03; Brown's station, in the Catskill watershed, 1.01. On the following day Aug. 13, at the Ashokan reservoir, Catskill watershed, a hundred miles from New York City, in round numbers, 2.6 in. of rain fell, but in the tributary watershed above the reservoir, the rainfall was almost nothing.

Mr. Brush adds that "in spite of the rainfall the flow of the Esopus stream [in August, up to the 19th] did not equal the draft of 500 m.g.d. [on the Ashokan reservoir] except for one day," and that for the 24 hr. ending 8 a.m., Aug. 19, the flow was 257 m.g."

Bids for Two Bridges Total Over $4,000,000

On Aug. 24 the Port of New York Authority received bids on the superstructure of two bridges over Arthur Kill between Staten Island, N. Y., and the New Jersey side of the channel described on p. 346 of this issue. The bids were as follows:

PERTH AMBOY-TOTTENVILLE BRIDGE

Bethlehem Steel Co.	$2,746,969
American Bridge Co.	2,616,089
McClintic-Marshall Co.	2,599,150

ELIZABETH-HOWLAND HOOK BRIDGE

Phoenix Bridge Co.	$2,262,192
McClintic-Marshall Co.	1,985,206
American Bridge Co.	1,899,999
Bethlehem Steel Co.	1,888,269

Contracts for the substructures were awarded early in August. The one for the New Jersey side of the Perth Amboy-Tottenville bridge to the P. J. Carlin Construction Co. and for the same side of the Elizabeth-Howland Hook bridge to the Triest Contracting Corp. Contracts for the Staten Island side of both bridges was let to the Frederick Snare Corp.

John F. Stevens Leads in Second A.S.C.E. Balloting

Canvass of the ballots in the "second ballot for official nominees" in the American Society of Civil Engineers gives the following results: For president, John F. Stevens, 2,579, and Anson Marston, 2,096 votes; for vice-president in zone 2 John C. Hoyt is practically unopposed. In zone 3 for vice-president, Arthur E. Morgan received 577 votes and Baxter L. Brown, 488. In the district where there is some contest for directors, the following votes were cast: District 1, George J. Ray, 611; George L. Lucas, 570; J. F. Sanborn, 277, and Aubrey Weymouth, 176. The name of Mr. Sanborn has been withdrawn at his request. Two directors are to be elected in District 1. In District 14, C. M. Buck received 208 votes and Don A. MacCrea, 79. In District 15, Jacob H. Brillhart received 160 votes, and Edward N. Noyes, 97. In District 4, Frank O. Dufour and in District 11 Harry W. Dennis are without opposition.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Providence, R. I., Sept. 14-17, 1926.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., Oct. 11-14, 1926.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Pinehurst, N. C., Nov. 8-12, 1926.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

THE ASPHALT ASSOCIATION, New York City; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

The Canadian Good Roads Association will hold its annual convention in Edmonton, Alberta, Sept. 28 to 30.

Personal Notes

G. R. WINSLOW who has been with the California Highway Commission since its establishment in 1912 has been relieved of the position of maintenance engineer under rules prescribed by civil service regulations, it is announced, and has been succeeded by T. H. DENNIS, formerly maintenance engineer in Division 3 who has been appointed acting maintenance engineer with headquarters at Sacramento.

JOHN F. O'ROURKE, formerly president of the O'Rourke Engineering Construction Co., New York City, is no longer connected with the company but is devoting his time to engineering as a consulting engineer with offices at 17 Battery Place, New York. The new officers of the O'Rourke Engineering Construction Co. consists of Innis O'Rourke, president; John F. O'Rourke, Jr., vice-president and treasurer; and Edward L. Howard, secretary.

THOMAS MCCABE, who was associated with the William Kennedy Construction Co. of Brooklyn for the past 17 years as construction superintendent has entered the field as a general building contractor, his firm being the THOMAS MCCABE CONSTRUCTION CO., INC., 153 Center St., New York City.

WILLIAM S. LALONDE, JR., now with the city engineer's office of Los Angeles, Calif., was recently appointed instructor in civil engineering at the University of Nebraska to succeed DON J. YOUNG who has accepted an engineering position with the Woods Brothers Construction Co. at Ottawa, Ill.

MURRAY H. HENRY of Pittsburgh, Pa., has been appointed materials engineer of the Bureau of Tests at Pittsburgh. B. R. WHITEHEAD was named senior assistant engineer of the Stores Division. Mr. Henry formerly was employed by the State Highway Department, and for three years he had charge of materials inspections in western Pennsylvania.

ROSS M. RIEGEL of Pittsburgh, Pa., has been appointed design engineer of the Department of Public Works of the city of Pittsburgh, a position recently created by the City Council. Mr. Riegel is a graduate of Cornell University and has had a long experience in hydroelectric work.

MAJOR E. L. DALEY, Corps of Engineers, who has been in charge of the Pittsburgh District and active in promotion of Ohio River improvement work, is to be sent to Fort Humphreys for some special work.

Obituary

JAMES MCKINNON, president of the McKinnon Construction Co. of Providence, R. I., died in that city Aug. 17, in his 59th year.

JOHN MANEY, railroad construction contractor and builder, with his brother, of the Choctaw branch of the Chicago, Rock Island & Pacific R.R. into Oklahoma City, died suddenly Aug. 15 at Enid, Okla., aged 59 years. The two brothers also built and for some time owned the Clinton, Oklahoma & Western Ry. from Clinton to Cheyenne, Wyo., but later sold it. They were also contractors for mill and other large buildings in the Southwest.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Manufacturers to Exhibit at New England Water Works Convention

The following applications have been received for the 45th annual convention of the New England Water Works Convention to be held at the Biltmore Hotel, Providence, R. I., Sept. 14-17. It is probable that further applications will be made.

Union Water Meter Co.
R. D. Wood & Co.
U. S. Cast Iron Pipe & Foundry Co.
George A. Caldwell Co.
A. P. Smith Mfg. Co.
Federal Meter Corp.
Public Works
Paradon Engineering Co.
The Pitometer Co.
Kennedy Valve Mfg. Co.
Hydraulic Development Co.
Central Foundry Co.
The American City
Pittsburgh Meter Co.
Bingham & Taylor, W. P. Taylor Co.
Lead Lined Iron Pipe Co.
Ross Valve Mfg. Co., Inc.
Wallace & Tiernan Co.,Inc.
Water Works Equipment Co.
Cement Lined Pipe Co.
Hersey Mfg. Co.
Red Hed Mfg. Co.
McWane Cast Iron Pipe Co.
Lock Joint Pipe Co.
Engineering & Contracting
Water Works Engineering
Norwood Engineering Co.
Mueller Company, Inc.
Neptune Meter Co.
Thompson Meter Co.
Engineering News-Record
George H. Snell
National Tube Co.
Chapman Valve Mfg. Co.
Edson Mfg. Co.
National Water Main Cleaning Co.
Rensselaer Valve Co.

Business Notes

EISEMANN MAGNETO CORP., New York, has recently occupied its new direct factory branch building in Detroit. The building is located at 6511 Lincoln Ave. in the automotive area surrounding the General Motors building.

GENERAL ELECTRIC CO., Schenectady, N. Y., announces that with the addition of 7,000 more Novalux street lighting units, which will be in operation by Dec. 15, Chicago will have the largest installation of residential incandescent street lights of one type of any city in the country. All the lighting units, totalling 15,500 in all, have been supplied by the General Electric Co. They consist of 250-cp. lamps in alabaster rippled globes, mounted on 12-ft. concrete octagonal poles.

L. N. RIDENOUR, formerly with Wellman, Seaver, Morgan Co., and later agent for the Contractors Equipment Co. in Cleveland, has been appointed special factory representative of the Harnischfeger Corp., Milwaukee, Wis. The Harnischfeger Corp. also announces that E. LYNN PUCKETT has been appointed district manager of the Charlotte, Va., office.

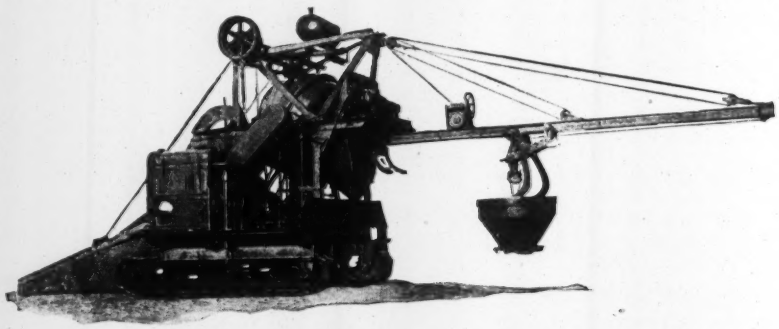
HYMAN-MICHAELS CO., Chicago, has purchased the Cleveland, Painesville & Eastern R.R., a short-haul line in Ohio, and will start immediately to dismantle the property and place it upon the market. The railroad company recently absorbed the Cleveland, Eastern & Ashtabula R.R., giving it a total of about 75 miles of right-of-way from Ashtabula to Cleveland. Competition with buses, autos, etc., is claimed to be the reason for the discontinuance of the line.

GENERAL EXCAVATOR CO., Marion, Ohio, which was recently organized and has purchased land, buildings and equiipment formerly the property of the Fairbanks Steam Shovel Co., is now rehabilitating and re-equipping the property. It announces that a new ¾-yd. combination shovel, dragline and crane, to be either gasoline or electric powered, will be announced soon.

New Developments

A New Paving Mixer in a 13-E Size

Having all the necessary features of a standard paver but with lighter weight and lower initial cost the 13-E paver recently introduced by The Construction Machinery Co., Waterloo, Iowa, utilizes the company's single opening tilting mixer design.

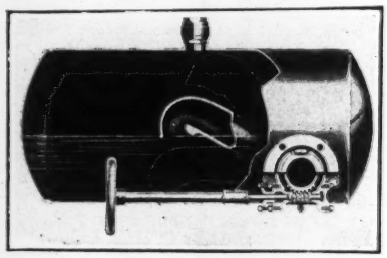


The power plant is a 30 hp., 4 cylinder engine, and the operating levers are grouped for one man control. The charging skip is of an open-end design for truck discharging. In charging and discharging the mixing drum a power tilt is used to automatically stop the drum in either position. The distributing bucket is designed to discharge at any point on the boom. Either crawler-treads or four road wheels are used, and a boom and bucket or a distributing chute is optional equipment.

Water System for 27-E Mixer Improved

The water-supply system for the 27-E concrete mixer manufactured by the Koehring Co., Milwaukee, Wis., has now incorporated all the improvements dictated by the tests on it which were reported in *Engineering News-Record*, June 3, 1926, p. 916, and is now offered as standard equipment on the company's pavers.

Three main advantages are claimed for the water system—(1) correct timing, (2) accurate measurement, and (3) straight flow. The charging skip automatically opens a balanced three-way valve, starting the discharge of water. The water enters the mixing drum just before the material enters, thus washing away all accumulation from the previous batch and assuring a clean drum. The automatic opening of the valve saves one operation for the



operator and is correctly timed with the other operations of charging, thus getting all the materials into the drum in a minimum of time.

The regulating valve determines the amount of water supplied to each batch. This water passes to the mixer drum through the measuring pipe inside of the tank as shown in the illustration. The adjustment of this measuring pipe for various quantities of water is controlled by a hand-wheel-operated worm and gear. The gearing is self locking in any position. The open end of the measuring pipe is always on an arc described along the center of the tank, regardless of the setting of the regulating valve. This assures the least deviation from accurate measurement when the mixer is working on a grade or super-elevated curve, which places the water tank in an inclined position.

The water in the tank from the top down to the opening in the end of the intake pipe can run into the mixing drum. As soon as the water gets below

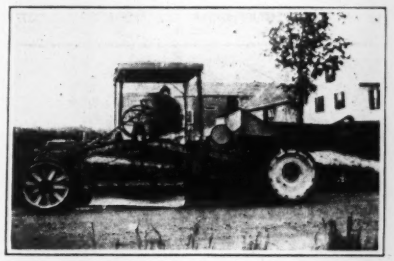
the intake mouth, the flow is immediately stopped because the air which has entered the drum through the check valve at the top breaks the siphon, which is the basic principle upon which the system operates.

The drum is tested to 150 lb. hydrostatic working pressure and is provided with a check valve which opens as soon as the balanced three-way valve is tripped, admitting air to the measuring tank and assuring a steady flow of water to the mixing drum.

Straight flow from the tank to the drum secures a fast discharge of water. The diameter of the discharge pipe is 3½ in.

Dump Body Mounted on Patrol Grader to Aid Repair Work

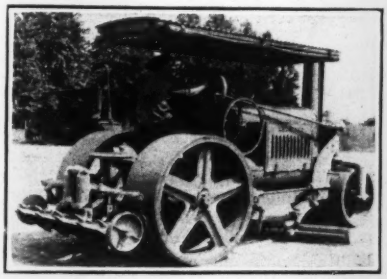
The Highway Department of the State of Maine has mounted a dump body on the rear of its Hadfield-Penfield one-man grader for the purpose of carrying stone for patching and repair jobs. With this equipment the road is not only scraped and graded, but any small amount of material for holes may be placed without the use of a separate



truck. The body dumps to the rear. Another advantage of carrying the dump body full of stone is the function it performs as a weight, steadying the grader, and it is claimed improving its scraping and grading abilities.

New Line of Heavy Duty Rollers and Graders

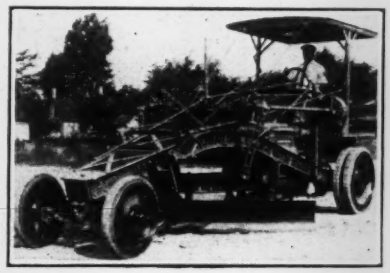
Built around the McCormick-Deering industrial tractor the new line of road rollers and graders developed by The Galion Iron Works & Mfg. Co., Galion, Ohio, supplements its similar equipment



using the Fordson power plant. The line contains three pieces of equipment, a roller, a grader with rear control, and a grader with center control.

The roller is made in 5, 6, 7 and 8 ton sizes. A nine-tooth scarifier is standard equipment, as is a fully adjustable planer. Gearing from the tractor axles to the rear rolls is said to increase the delivered power of the tractor from 50 to 60 per cent.

The motor grader with rear control is known as the International E-Z Lift



motor grader. It utilizes the company's patented lifting device for the blade. Cab and curtains can be provided if desired. Blade and mouldboard are available in 8, 10, 12 or 14 ft. lengths. Dual rubber tired rear wheels, rollers or crawlers may be supplied as preferred. This grader also utilizes a scarifier which is independent of the blade in operation. Forty-inch lift wheels are used.

The International standard motor grader is similar to the above but uses

an open lift gearing instead of the worm gearing of the E-Z Lift. The operator's position is at the center of the machine.

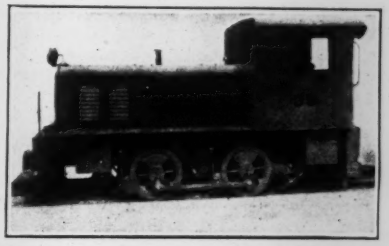
Huge Bridge Crane Completed for Ore Handling at Indiana Harbor

The McMyler-Interstate Co., Cleveland, has recently completed two of the largest bridge crane installations in the country for the Inland Steel Co. at its Indiana Harbor plant. The cranes are being used for ore handling from the lake freighters. Each crane is made up of a center span of 265 ft. with a 65-ft. cantilever on one end and a movable apron extension of 99 ft. on the other end, providing a total trolley travel of 429 ft. Provision is made for skew in either direction, but electric skew-limit cut-outs have been provided in order to keep this down to a safe amount. The main hoist motors are rated 275 hp. each. Buckets with a capacity of 15 tons or slightly under 9 cu.yd. are provided. These are of the rope reeved type, equipped with manganese steel lips and stand about 17 ft. high.

Three-Point Chassis Suspension for Gasoline Locomotives

Gasoline locomotives in sizes from 8 tons up, manufactured by the Vulcan Iron Works, Wilkes-Barre, Pa., are now equipped with elliptic springs and cross-equalizers giving three-point suspension of the chassis. The main advantage claimed for three-point suspension is the elimination of derailment, since the weight of the locomotive is equalized on all bearings regardless of unevenness of the track.

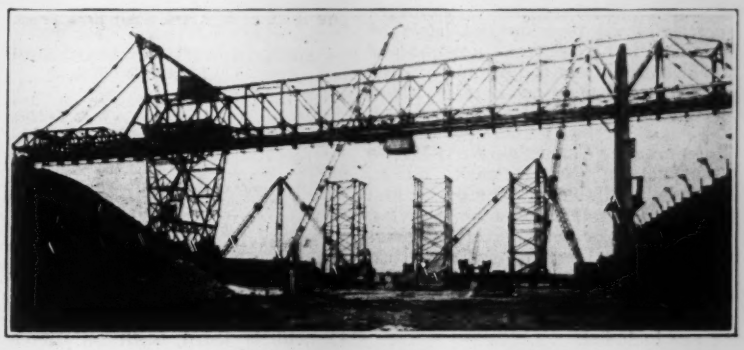
Three-point suspension is standard practice on steam locomotives, Vulcan electric locomotives are of this design,



and the heavy Vulcan gasoline locomotives (from 16 tons up) have always been so constructed, but this is claimed to be the first instance in which a three-point suspension design has been used on smaller gasoline locomotives.

Truck Cranes Announced in 6 and 7½-Ton Capacities

The first radical change in the truck crane manufactured by the Universal Crane Co., Cleveland, Ohio, in a good many years has resulted in two new cranes of heavier capacities. These 6 and 7½-ton units will supplement the 5-ton machine that has been in use. Each of the new units is rated at 10-ft. radius. Their appearance and size are the same as the present 5-ton crane. They are full revolving with a swing



speed of 6 r.p.m. and a rope speed of 140 ft. per minute. The power unit in each case is a 44-hp. Waukesha gasoline engine. The swinging and hoisting operations are carried out by three levers and one foot pedal. Booms of various lengths for different job requirements may be furnished. The units are suitable for motor truck, crawler, railroad flat car, and trailer mountings.

New Publications

Power Shovels—THEW SHOVEL CO., Lorain, Ohio, devotes its latest publication to the Lorain 75, its newest design of power shovel using either a gasoline engine or electric motor. Illustrations and descriptions are given of the details of the machine both as a power shovel and crane, while the mechanical details of the operating mechanism are separately photographed and described. Clearance diagrams and several pages of job illustrations, in addition to some tables giving the weights of various volumes of different materials, complete the catalog.

Structural Beams—JONES & LAUGHLIN STEEL CORP., Pittsburgh, has issued a new booklet on its new J & L beam. It contains working tables and other data necessary in the application of this new beam to its use in construction, especially for floors and roofs.

Tractors—MONARCH TRACTOR CORP., Springfield, Ill., has issued a booklet describing its new 5-ton Monarch tractor. A separate paragraph is devoted to every important detail of the machine, so that the specifications given are unusually complete.

Steel Building Products—TRUSCON STEEL CO., Youngstown, Ohio, has issued a revised catalog on its "Permanent Building Products." It is a convenient handbook on building products of steel, including such items as steel casements, sash, basement windows, doors and frames, metal lath, corner beads and channels, steel joists, reinforcing steel and accessories, and road forms.

Cement Lined Pipe—CEMENT LINED PIPE CO., Lynn, Mass., devotes a new 20-page booklet to its cement lined pipe for corrosive water. The booklet is a technical discussion of the advantages of cement lined pipe on the basis of resistance to corrosion, amount of water delivered, and condition of water delivered. Information is also given on cost and installation of these pipes.

Waterproofing Concrete—ANTI-HYDRO WATERPROOFING CO., Newark, N. J., has made available to engineers and architects a specification folder, giving specifications for waterproofing, mass concrete, stucco, cement mortar, brick, block, stone masonry, etc. Tables of concrete slab thickness for various water pressures and other pertinent data are included.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Aug. 26, 1926	$15,184,000	$26,549,000	$41,733,000
Aug. 19, 1926	34,682,000	34,671,000	69,353,000
Aug. 27, 1925	40,350,000	27,751,000	68,101,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	739,274,000	1,162,848,000	1,902,122,000
1925	716,027,000	884,004,000	1,600,031,000

Foreign Building Materials Arriving in Increasingly Larger Quantities

Brick, Steel Bars, Shapes and Pipe, Cement, Plate Glass, Boards, Planks, Lath All Gaining—Shingles Show Decline

OF THE ten important classes of construction materials imported into the United States during the first quarter of the current year, only one (wooden shingles) failed to register a substantial gain over the corresponding period in 1925. That demand is particularly slow for the material forming the exception is substantiated by the recent statement of the Department of Labor that "of all the different building materials commonly used in the construction of dwelling houses the wooden shingle has shown the least advance since pre-war years."

Turning attention to the nine classes that did gain, it is found that common building brick stands out conspicuously in the list. The total value, at foreign dock, of the 41,145,000 brick imported during the first six months of this year was $341,031. At the present rate of shipping, 1926 will show a gain in money value of brick imports of 288 per cent compared with last year.

FOREIGN AND DOMESTIC BRICK SHIPMENTS

1926	From Foreign Countries to U. S.	From Domestic Brickyards
January	6,466,000	108,688,000
February	3,540,000	110,866,000
March	4,611,000	150,485,000
April	7,436,000	146,431,000
May	6,274,000	192,065,000
June	12,818,000	149,170,000
6 Months	41,145,000	857,705,000

Next to brick come steel bars, with a gain of 109 per cent, comparing the first quarter of this year with last. Cement is third, with an increase of 65 per cent; plate glass fourth, with a 55 per cent gain; iron and steel pipes and tubing fifth, with 37 per cent increase. After these, in the order named, come logs and timbers; boards, planks, etc.; lath; and structural shapes and building forms of iron and steel.

IMPORTS OF CONSTRUCTION MATERIALS FIRST QUARTER THIS YEAR AND LAST

	1926 Lbs.	1925 Lbs.	Per Cent Gain (+) or Loss (—) in 1926
Steel bars	44,059,000	21,081,000	+109.0
Structural shapes and building forms of iron and steel	35,765,000	34,331,000	+ 4.2
Pipes and tubing, iron and steel	32,500,000 (Sq.ft.)	23,621,000 (Sq.ft.)	+ 37.6
Plate glass	6,069,000 (M. ft. b.m.)	3,905,000 (M. ft. b.m.)	+ 55.4
Boards, planks, etc	422,000	381,000	+ 10.8
Lath	424,000	396,000	+ 7.1
Logs and timber	48,219 (M.)	41,933 (M.)	+ 15.0
Shingles	388,000	482,000	— 19.5

Imports of boards, planks, etc., for the first quarter, were valued at $12,511,000 as against $11,573,000 for the same period last year, representing a gain of 8.1 per cent. Glass and glass products totaled $4,569,000, compared with $4,010,000 in the first quarter of 1925, a gain of 13.9 per cent this year.

Pig iron imports, Jan. 1 to April 1, 1926, amounted to 363,709,000 lb., against 313,488,000 lb. for the corresponding period last year, a gain of 16 per cent.

(*Continued on p. 361*)

Movement of July Improvement Bonds Slowest For That Month Since 1923

STATE and municipal bond sales during the month of July showed a decided drop according to *The Commercial and Financial Chronicle*. Awards totaled $86,384,995 as compared with $144,630,193 of July a year ago. In 1921 the total for July was $104,584,124, in 1922 $94,616,091, in 1923 $67,776,833, in 1924 $117,123,679.

Some of the large placements made during July of this year follow: twenty-one issues, $8,766,000 4½s, Pittsburgh, Pa.; four issues, $5,000,00 4s, Philadelphia; two issues, $2,187,000 6s and 5½s, Coral Gables, Fla.; $2,000,000 5s, Seattle, Wash.; $2,000,000 4½s, Oakland, Calif.; $1,971,000 4½s, Newark, N. J.; ten issues, $1,870,000 6s, Pinellas County School District, Fla.

In studying bonds recorded it is found that the four classes (State, County, School District, City and Town) ranked in percentages of the yearly total as follows:

Year	State	County	School District	City, Town
1921	24.11	16.76	11.79	47.34
1922	13.36	19.19	14.94	52.51
1923	21.89	16.04	14.30	47.77
1924	17.83	14.78	12.47	54.92

During the years, 1921-1924, the municipal bond issues were for the following purposes:

	Per Cent of Yearly Total			
	1924	1923	1922	1921
Water	10.31	8.168	8.50	6.57
Streets, roads	27.22	29.58	31.21	32.51
Sewers	6.75	8.392	8.30	6.06
Schools	20.62	19.59	21.53	17.96
Buildings	6.34	4.444	3.64	3.44
Parks	2.20	2.811	1.76	1.85
Light and gas	1.46	1.486	2.51	1.19
Funding	1.16	1.827	1.93	1.62
Improvement	7.70	5.972	4.99	6.31
Soldier bonus	5.15	8.654	3.70	7.78
Flood prevention	1.15	0.381	0.416	0.189
Harbor, water front	1.89	1.837	4.055	1.073
Rapid transit, piers and canals	1.85	1.704	0.989	6.453
Irrigation	1.38	1.361	2.201	0.808
Miscellaneous	3.44	1.905	1.553	5.388

REPRESENTATIVE PUBLIC BOND SALES, JULY, 1926

State	Purpose	Amount	Rate per Cent	Sold For	Basis	Dated	Maturity	Purchased by
Delaware	Highway	$500,000	4	99.439	4.03	Jan. 1	1966	Barr Bros., Inc. of N. Y. C.
New Jersey	Road	3,000,000	4½	103.16	....	.....	.....	Atlantic Co. Trust Co. of Atlantic City and others
	Bridge	2,000,000		103.16	....	.....	.....	
	Highway	2,000,000		103.25	....	.....	.....	
South Dakota	.....	1,750,000	4½	.....	....	July 1	1941–46	Barr Bros., Inc. and others
County								
Anderson, Ky	Road	100,000	4½	102.11	....	July 1	1931–53	J. J. B. Hilliard & Son of Lousiville
Anderson, Tenn	Road	115,000	5	.....	....	Mar. 1	1946–55	Rogers, Caldwell & Co. of N. Y. C.
Alameda, Calif	Tube	500,000	5	103.49	4.36	.....	1931–34	Dean Witter & Co. and others
Appanoose, Iowa	Road	160,000	4½	100.75	4.40	Aug. 1	1931–40	First Wisconsin Co. of Milwaukee
Beaver, Pa	Bridge	590,000	4½	101.75	4.12	Aug. 1	1935–54	The Guaranty Co. of New York
Bertie, N. C	Road	300,000	4½	101.82	4.62	July 1	1932–66	A. T. Bell & Co. of Toledo and others
Berks, Pa	Road	2,000,000	..	101.02	....	June 29	.....	Reading Nat. Bank of Reading
Broward, Fla	Highway	500,000	5½	97.63	5.70	July 1	1935–49	Wright, Warlow & Co. of Orlando
Cass, Mich	Road	11,700	6	102.50	5.49	May 1	1928–36	Cass County State Bk. of Cassopolis
Carroll, Md	Road	39,000	4½	101.769	4.14	July 1	1929–36	John P. Barr & Co. of Buffalo
Clarion, Pa	Road	80,000	4½	101.47	4.11	July 1	1940–44	National City Co. of N. Y.
Cass, Ind	Road	197,000	4½	101.55	....	July 10	10 yrs.	Union Trust Co. of Indianapolis
Clinton, N. Y	Highway	52,000	5	103.21	4.37	Feb. 15	1927–37	Geo. B. Gibbons & Co. of N. Y. C. and others
Daviess, Ind	Road	44,380	4½	101.40	....	June 25	10 yrs.	J. F. Wild & Co. of Indianapolis and others
Decatur, Ind	Road	185,000	4½	101.44	4.20	May 15	1936	Fletcher Savings & Trust Co. of Indianapolis and others
Elkhart, Ind	Highway	38,000	4½	102.30	....	June 19	1 to 20 yrs.	J. F. Wild & Co. of Indianapolis
Flagler, Fla	Court House	75,000	6	95.05	6.37	Jan. 1	1956	Prudden & Co. of Toledo
Franklin, Ky	Road	150,000	4½	100.11	....	.....	.....	L. R. Ballinger & Co. of Cincinnati
Huron, Mich	Road	225,000	5	100.27	4.95	May 1	1927–36	Bumpus & Co. of Detroit
Jackson, Tenn	Road	64,000	5	100.57	4.95	April 1	30 yrs.	Caldwell & Co. of Nashville
	School	40,000						
Mahaska, Iowa	Road	200,000	4½	100.69	4.40	Aug. 1	1929–43	Ringheim & Co. of Des Moines
Montgomery, Md	Road	48,000	4½	102.845	4.19	.....	1927–50	John P. Baer & Co. of Baltimore and others
Township								
Teaneck, N. J	Public Impvt.	129,000	4½	101.23	4.65	July 1	1927–66	Outwater & Wells of Jersey City
York, O	Road Impvt.	15,000	6	106.37	4.78	July 1	1927–36	Seasongood & Mayer of Cincinnati
Knox, Pa	Road	14,475	4½	100	4½	June 14	1927–36	J. W. Hoover and Wm. J. Geary
Municipal								
Agar, S. D	Water Works	11,000	6	101.13	....	July 1	1936–47	Agar State Bank of Agar
Alliance, O	Sewage disposal	100,000	5	105.289	4.45	Mar. 1	1928–52	Howe, Snow & Bertles of Chicago
Ansonia, O	.....	35,512	6	101.72	5.25	June 1	1927–32	Otis & Co. of Cleveland
Akron, O	Street Impvt.	459,700	5	102.099	4.45	Aug. 1	1927–36	W. K. Terry & Co. of Toledo
Avon, N. Y	Fire Equip.	13,000	..	.....	....	Aug. 1	1927–39	State Bank of Avon
Bucyrus, O	Paving	17,500	5	101.68	4.65	July 1	1927–35	First Citizens' Corp. of Columbus
Clinton, N. Y	Street Impvt.	60,000	4½	100.61	4.41	Aug. 1	1927–46	Sherwood & Merrifield, Inc. of New York
Collingswood, N. Y	Water	190,000	5	.....	....	July 1	1932–36	M. M. Freeman & Co. of Philadelphia
	Improvement	434,000						
Defiance, O	Streets	5,110	5½	102.73	4.83	July 1	1928–33	Ohio State Teachers' Retirement System
Dickinson, N. Y	Water	2,300	5	102.39	4.57	July 1	1931–35	Geo. Gilbert of Port Dickinson
Dilworth, Minn	Water Works	25,000	4½	100	4½	July 26	.....	Elliott, McGraw & Co. of St. Paul
Ferndale, Mich	Paving and Sewer	224,300	4½	.....	....	June 15	1927–30	Lewis & Co. of Detroit
Fort Edward, N. Y.	Paving	12,000	4½	100	4½	July 1	1930–35	Fort Edward National Bank
Fort Meade, Fla	Impvt.	180,000	6	95	6.43	June 1	1931–56	Brown-Crummer Co. of Wichita
Haddonfield, N. J	Water and Sewer	115,000	..	100.39	....	.....	.....	M. M. Freeman of Philadelphia
Hastings, Neb	Sewer	150,000	..	100.14	....	.....	.....	United States Trust Co. of Omaha
Hohenwald, Tenn	Water Works	55,000	6	101.54	5.85	Aug. 1	1931–51	First National Bank of Memphis
Lakeland, Fla	Impvt.	1,068,000	..	97.27	....	June 1	1927–56	Prudden & Co. of Toledo and others

Foreign Building Materials, Etc.

(*Continued from p. 360*)

An acute situation prevails in steel bars that is by no means confined to the New York district. Over 72 per cent of the reinforcing bar tonnage recently let on the Conowingo Dam, a $52,000,000 project (general contract awarded in March to Stone & Webster of Boston) was awarded to Belgian makers at $1.75 per 100 lb., duty paid. The minimum price on domestic bars is $1.90 per 100 lb. at mill.

Warehousemen in the New York district complain of underselling on the part of foreign bar dealers, to the extent of $2 to $5 per ton.

During the last week, 7,300 tons of steel rails were received at Boston for the B. & M. R.R. from the Krupp Works in Germany.

Up to the present time, that is, since the building boom got into full swing early in 1923, common building brick have been coming in from Belgium, Germany, Holland, Canada, Italy, England, Mexico and Spain. Latest reports, however show Canada, the United Kingdom and Italy in the lead, so far as brick shipments to the U. S. are concerned.

In the accompanying tabulations the import figures are from the Bureau of Foreign and Domestic Commerce; the domestic brick statistics, from the Common Brick Manufacturers' Association of America; and the domestic cement shipments from the Bureau of Mines.

FOREIGN AND DOMESTIC CEMENT SHIPMENTS

	From Foreign Countries to U. S.		From Domestic Mills	
	1926 Bbl.	1925 Bbl.	1926 Bbl.	1925 Bbl.
January	360,580	231,258	5,672,000	5,162,000
February	314,118	119,077	5,820,000	6,015,000
March	493,241	218,048	9,539,000	10,279,000
April	257,302	197,686	12,961,000	14,394,000
May	223,130	186,897	17,951,000	16,735,000
June	335,570	254,937	19,113,000	17,501,000
6 Months	1,983,941	1,207,903	71,056,000	70,086,000

Weekly Construction Market

WITH the exception of lumber and brick, construction materials prices are noticeably on the up-grade.

Last year an upward movement occurred in the late summer and continued throughout the fall, while this season it appears to have started earlier.

Brick prices are steady, the country over, at levels more than twice as high as those of 1913. Other materials run from 30 to 82 per cent above the 1913 levels.

Lumber prices started to decline in January, this year, and have followed in a downward direction since then, although the changes have at no time been abrupt.

The present weakness in steel is due more to cutting under on the part of foreign makers, than to actual slump in domestic demand.

In the current iron and steel market decided firmness is noted in pig iron although small lot buying persists without actual upward movement in quotations. A rise of 50c. per ton in furnace coke is reported at Connellsville.

The range remains about the same as a week ago on the principal hot-rolled steel products. Shapes, plates and bars hold at the minimum quotation of $1.90 per 100 lb., Pittsburgh mill, on large tonnages, with a maximum of $2.10 applying on small lots of shapes and bars and $2 on plates.

Railroad buying of equipment continues fairly active. The American Locomotive Co. reports orders from one of the New York Central Lines (C. C. C. & St. L. Ry. Co.) for ten Pacific type locomotives (300,000 lb.), also ten Mountain type locomotives for the M. St. P. & S. S. M. Ry. Co. (336,000 lb.) and ten Mallet type locomotives (560,000 lb.) for the N. & W. Ry. Co.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montrea
Steel Products									
Structural shapes, 100 lb.....	$3.34	$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	—$3.75
Structural rivets, 100 lb.....	4.20	5.00	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb..	3.24	2.80	3.38	2.60	2.87½	3.77½	2.95	3.25	2.50
Steel pipe, black, 2½ to 6 in. lap, discount.....	48%	54%	53.6%	51%	54.25%	36%	35.6@49.2%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	51.60@53.60	45.25	54.00	49.20@50.20	53.00	64.00	50.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.....	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd.....	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd.....	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd.....	1.85	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.....	62.00	34.00	56.00	40.50	38.25	34.75	27.00	23.00	50.00
Lime, finishing, hydrated, ton.....	18.20	23.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.....	2.10@3.00	1.50	1.85	2.25	1.60@1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000...	20.40@22.40	10.50	14.10	12.00	13.75	9@10	15.00	15.00	—20.25
Hollow building tile, 4x12x12, per block.....	Not used	.0895	.112	.075	.076	.075	.....	.09	.10
Hollow partition tile 4x12x12, per block.....	.1112	.0895	.112	.075	.076	.075	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, gal....	.95¼	.99¾	1.13	+.92	1.03½	1.14	+1.04	1.12	1.03
Common Labor									
Common labor, union, hour.....	.90⅜	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour...	.....	.25	.30@.50	.82½	.45@.60	40@.45	.50	.50	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Aug. 5 the next on Sept. 2.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½... Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.156). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, less-than-carload lots.

Business Briefs

Call money quoted at 4½ per cent, Aug. 24; year ago 4 per cent.

Time loans: Sixty-ninety days, 4¾; four-six months, 4¾@5 per cent.

Commercial paper: Best names 4¼ per cent; other names, 4½ per cent.

On Aug. 1, 1926

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For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month